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MANUAL

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PUPILLIDÆ

(VERTIGININÆ, PUPILLINÆ)

BY

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MANUAL OF CONCHOLOGY

Family PUPILLIDÆ Turton.

Subfamily VERTIGININÆ, continued.

Genus PRONESOPUPA Iredale.

Pronesopupa IREDALE, Proc. Malac. Soc. London, x, 1913, p. 384, for *P. senex*.

The shell is similar to *Nesopupa* except that the aperture is toothless; outer lip reflected, the lip insertions remote. Living on trees or plants.

The species are illustrated on plate 1.

The arboreal *P. senex*, of Kermadec, type of this genus, is not known to us by specimens, and we have not seen *P. simplaria* Pease, of the Marquesas, which appears to belong here. The Hawaiian species which we now place in *Pronesopupa* by having cuticular laminæ on the ribs, or "membranous ribs", agree with numerous toothed Hawaiian forms of Nesopupa. It appears likely that they were derived from the *Limbatipupa* group of *Nesopupa* by loss of teeth. It is quite possible that *Pronesopupa senex* is a similar derivative from some other dentate stock of southern *Nesopupæ*.

The negative character of being toothless has little weight in phylogeny, but we have nothing better at present; when the radulæ of *P. senex* and the Hawaiian species can be compared a further step may be taken.

1. PRONESOPUPA SENEX Iredale. Pl. 1, figs. 8, 9.

"Shell minute, pupoid, dextral, few whorls. Color brown. Whorls 4; the first whorl and a half smooth; the succeeding whorls have a sculpture of distant sharp lamellæ, the intervening spaces threaded with striæ; in some shells the lamellæ

are obsolete, or only occur on the last half whorl, whilst in others they regularly appear on each whorl; on the last whorl about a dozen can be counted, either indistinct or very prominent. A narrow, deep umbilicus is present. The columella is straight and reflected; aperture discontinuous, almost circular, with the outer lip reflected and expanded. In general shape the specimens vary, some being more loosely coiled than others which have a humped-up appearance. Height 2, breadth 1.25 mm." (*Iredale*).

Kermadec Group: Sunday Island. Living on tree trunks, not moss-covered, and hiding in the crevices of bark in dry weather (Iredale).

Pronesopupa senex IREDALE, Proc. Malac. Soc. London, x, Sept. 1913, p. 385, pl. 18, figs. 1, 2.

No species, in any way allied to this, has yet been recorded from New Zealand, though I have seen very similar shells with the mouth fully armed from Fiji. Nothing of this nature has yet been found on Lord Howe Island, but the species named *Vertigo norfolcensis* by Sykes, from Norfolk Island, is referable to *Nesopupa;* it is, however, very much larger and sinistral (*Iredale*).

2. PRONESOPUPA SIMPLARIA (Pease). Not figured.

Shell thin, obesely ovate, dextral, rimate, yellowish, longitudinally delicately striate; whorls 3, rounded-convex, the last flattened; suture deeply impressed; apex obtuse; aperture nearly circular, toothless; peristome thin, margins separated; columella spreading above, slightly expanded. Length 1.75, diam. 1 mm. (*Pease*).

Marquesas.

Vertigo simplaria PEASE, Proc. Zool. Soc. Lond., 1871, p. 461.

Collector unrecorded. The species was not found by Garrett, who catalogued the Marquesan shells in 1887. This species could not be found in the Pease collection in the Museum of Comparative Zoology, and is known by the above description only.

Hawaiian Species of Pronesopupa.

BY C. MONTAGUE COOKE AND H. A. PILSBRY.

The shells are minute (1.4 to 2.7 mm. in length), fragile, dextral, perforate, ovately conic to conic-helicoid, costate, with 4 to 5½ whorls. The embryonic whorls are minutely granulose. Aperture *without palatal plicæ;* in one species (*P. boettgeri*) there are one or two minute lamellæ on the parietal wall and occasionally there is a swelling or a minute, deeply-seated fold on the columella. Lip insertions remote.

The animal is like *Lyropupa, Nesopupa* and *Vertigo* in lacking inferior tentacles. No muscular waves of the sole were noticed in crawling.

Nearly all the species are arboreal in habit, being found either on the trunks of trees, the branches of bushes or on the leaves of low-growing plants. A very few specimens have been taken on the ground, on mossy stones or dead leaves, probably fallen from plants.

Key to Subgenera and Species of Hawaiian Pronesopupæ.

a^1. Adult shells with 4-4¼ whorls; costæ with membranous margins, often forming spine-like processes at the shoulder.

b^1. Surface of embryonic whorls minutely granulose, and in addition, furnished with very *minute raised spiral lines;* 35-40 costæ on the last whorl (Section *Edentulopupa*). *P. admodesta,* no. 7.

b^2. Surface of embryonic whorls minutely granulose, the granules arranged in transverse rows, and without spiral lines; 20-30 costæ on the last whorl (Section *Pronesopupa* proper).

c^1. Costæ uniform in height, not armed with spines. *P. acanthinula,* no. 3.

c^2. Costæ armed with spines.

d^1. Aperture without teeth.

e^1. Diameter 80-85% of the length. *P. b. spinigera,* no. 6.

e^2. Diameter 95-100% of the length. *P. hystricella,* no. 4.

d^2. Aperture furnished on the parietal wall with a minute angular or parietal lamella, more often with both.

P. boettgeri, no. 5.

a^2. Adult shells with 5-5⅔ whorls; costæ *without membranous* edges; last whorl with more than 45 costæ (Section *Sericipupa*).

b^1. Whorls closely coiled, convex.

c^1. Adult shell with diameter less than 55% of length. Hawaii. *P. orycta*, no. 13.

c^2. Adult shells with diameter more than 55% of length. *P. lymaniana*, no. 12.

b^2. Whorls more loosely coiled, very convex.

c^1. Adult shells more than 2.2 mm. in length.

d^1. Adult shells about 2.7 mm. in length. Hawaii. *P. sericata*, no. 11.

d^2. Adult shells about 2.3 mm. in length. E. Maui. *P. f. corticicola*, no. 8*a*.

c^2. Adult shells less than 2.1 mm. in length.

d^1. Adult shells less than 2.0 mm. in length.

e^1. Adult shells between 1.9 and 2.0 mm. in length. Molokai. *P. molokaiensis*, no. 9.

e^2. Adult shells between 1.7 and 1.8 mm. in length. Kauai. *P. incerta*, no. 10.

d^2. Adult shells between 2.0 and 2.1 mm. in length. E. Maui. *P. frondicola*, no. 8.

Section *Pronesopupa*.

In Hawaiian species the shell is minute, dextral, perforate, ovately conic-helicoid, with 4-4½ whorls. Embryonic whorls granulose, the granules arranged in transverse rows, towards the last of the second whorl the granules uniting into distinct costæ. Margin of the costæ sharp, thin, transparent, membranous, often extended into membranous spines, the interstices covered with minute wrinkles. Aperture truncate above, the lip insertions remote. The outer lip thin, slightly

expanded, the columellar margin broadly so. Aperture unarmed (except in *P. boettgeri*, which has sometimes a very minute angular, sometimes a minute parietal lamella, but more often is furnished with both). There are no palatal plicæ.

Reproduction ovoviviparous.

The Hawaiian species given below are provisionally located with *P. senex*. Unfortunately the microscopic surface characters of Iredale's species are not known to us, but from the description and figures of his species (having 4 whorls and with rather few distinct costæ), *P. senex* and the Hawaiian species seem to be closely related.

Nearly all the species belonging to this section are found at rather low elevations, very few, as far as known, being found much above 2,000 feet elevation. They are to be looked for in almost any damp locality, especially in what is known as the Kukui-belt (*Aleurites moluccana*).

3. Pronesopupa acanthinula (Anc.). Pl. 1, fig. 7.

"Shell perforate, thin, transparent, dark corneous, globose, hardly pupoidal, sculptured with moderately distant and thin acute lamellæ, very delicately and obliquely wrinkled in the interstices (visible with a strong lens). Spire globose-elevated, very obtuse. Whorls 4, convex [separated] by an impressed suture, increasing regularly, the upper smooth, the last globose, large, slightly oblique, saccate, not ascending. Aperture oblique, large, toothless, slightly flattened on the right side, angularly, very slightly produced forward in front of the middle, obliquely truncate-ovate. Peristome slightly expanded, regularly dilated at the columella. Length 1.5, diam. 1.5; alt. aperture 0.75 mm. Makiki, Oahu (Baldwin" (*Anc.*).

Length 1.4, diam. 1.25 to 1.27 mm. Rim Tantalus bowl, s.-w. Oahu, Koolau Range: Kahana, Kaipapau, Kaliuwaa and Waiahole (Cooke); Kalihi (A. Gouveia); Makiki (Baldwin, M. Desnouee); Tantalus (Cooke and Pilsbry); Palolo (Bridwell); fossil at Malaekahana and Punaluu (Cooke). Waianae Range: Green Peak and Palehua (Cooke), Kaala (Bridwell).

Molokai: Pelekunu (Forbes), Mapulehu, Kalamaula (Cooke).

West Maui: Waikapu, Honokahau (Forbes), Iao, Waihee (Cooke). East Maui: Kaupakalua, Keanae (Baldwin), Kailua, Alalele (Cooke).

Hawaii: District of Hilo (Forbes, Thaanum); Reed's Island, four miles Olaa Road, Rainbow Falls (Cooke), Maulua Gulch (Thaanum). District of Puna (Thurston and Thaanum), Kaueleau, Keaau, Pahoa (Thurston), Olaa (Lyman and Cooke). District of South Kona: Hookena (A. Gouveia), Honomalino (Thurston), Kapua (Forbes). District of North Kona: Holualoa, Waiaha and Hienaloli (A. Gouveia). District of Hamakua; Keehia (Thaanum), Waipio (Baldwin), *Fossil* Mana (Thaanum). "Central" Hawaii (Forbes).

Lectotype 12509, Cotypes 18695, Bishop Museum.

Pupa acanthinula ANCEY, Mém. Soc. Zool. de France, v, 1892, p. 709.

P. acanthinula appears to be widely distributed on all the islands except Kauai and Lanai. No specimens have, as yet, been reported from these two islands. Except for the shells collected by Mr. Forbes from "Central Hawaii", all of the specimens here examined came from elevations of less than 1,000 ft. The species is usually found on the trunks of trees, or the leaves of low shrubs or plants. Very few specimens have been found on the ground, or on dead leaves or stones.

Ancey's type material consists of eight individuals, of which six are in good condition. One of these has been chosen to represent the species. This specimen measures: length 1.7, diam. 1.55, aperture, oblique alt. 0.93 mm. The differences between these measurements and those given by Ancey are probably due to the method of taking them. In none of Ancey's type material, though carefully measured, is the diameter equal to the length. The smallest adult of Ancey's type material measures: length 1.6, diam. 1.32, aperture 0.98 mm. In none of the specimens is there any indication of parietal or angular lamellæ. *Acanthinula* is most easily recognized by its rather widely spaced riblets, 20-25

on the last whorl. They are thin, membranous, of a uniform height, the upper part not being produced into a spine. The interstices between the riblets of the last whorl are covered with very minute, close, discontinuous wrinkles. In an embryonic specimen from Hawaii, the mother of which is identical with Ancey's types, the surface is minutely, though distinctly, closely punctate, the points being arranged in axial rows; with the growth of the shell these points gradually unite, forming low close riblets.

4. PRONESOPUPA HYSTRICELLA n. sp. Pl. 1, fig. 12.

The shell is perforate (umbilicus small, circular, open, deep, largely covered by the dilated columellar lip), helicoid, clay color, thin, subtranslucent, conspicuously costate; the riblets delicate, thin, transparent, membranous, forming on the last and penult whorls, just above the periphery, delicate, flat spines. Spire depressed, with slightly convex outlines and obtuse apex, the whorls very convex and separated by a deep suture. Whorls 4, the embryonic 1½ whorls finely and closely granulose, the granules more or less arranged in transverse rows, gradually forming riblets towards the end of the second whorl, the last two whorls being strongly costate; the last whorl very large, depressed, convex around the umbilicus, slightly descending near the aperture, furnished with 28-30 costæ, about 0.2 mm. apart, the intercostal surface being more or less evenly minutely wrinkled. Aperture large, oblique, truncate-ovate, slightly flattened on the right side, forming a blunt angle at the shoulder, toothless. The outer edge of the peristome is slightly expanded, thin; the columellar margin broadly dilated above the columella.

Length 1.65, diam. 1.6, aperture, greatest length 0.92 mm.

Length 1.5, diam. 1.7 mm.

Hawaii: Hilo, Reed's Island (type loc.); Holotype 11032 Bishop Museum, Paratypes 23233 Bishop Museum and A. N. S. P.

Kauai, a single specimen; Oahu, common; Molokai, not rare; Lanai, a single young specimen, doubtfully reported to this species; W. Maui, not rare; E. Maui, rather common; Hawaii, common.

This is the most widespread species of *Pronesopupa* in the Hawaiian Islands, though it is not as frequently collected as *P. boettgeri* or *P. boettgeri spinigera*. It is found under the same conditions as these two forms, though more rarely taken on stones or dead leaves. Fossil specimens have been found in several recent deposits on Oahu, and two or three on Hawaii. They are usually quite rare in any deposit.

This species is easily recognized by its helicoid form. The spine-like processes of the costæ are extremely delicate and are easily rubbed or broken off in handling the specimens. These spines are longer and narrower than those of *boettgeri* or its subspecies. In the large series of this species examined no specific or varietal differences were found in the shells from the different islands.

In the fossil specimens examined the costæ are low, of a uniform height, the processes having doubtless been broken off.

In embryonic specimens of nearly two whorls from the type lot, the shells are flat; the beginning of the first whorl is immersed and the rest of this whorl hardly projecting above the second whorl. The surface is granulose or punctate, the minute granules being arranged in transverse rows, gradually forming costæ near the end of the second whorl.

5. PRONESOPUPA BOETTGERI n. sp. Pl. 1, fig. 17.

The shell is perforate (umbilicus small, circular, about ⅛ the diameter of the shell), globosely conic, buckthorn brown, costate; the costæ delicate, thin, transparent, membranous, forming on the last and penult whorls triangular tooth-like processes, abrupt on the lower margin but above tapering more gradually. Spire with convex outlines, the whorls very convex, separated by a very deep suture. Whorls 4, the embryonic whorls indistinctly punctate, the costæ not appearing until near the end of the second whorl. The last whorl is very large, somewhat saccate, convex about the umbilicus, ascending slightly near the aperture, with 26-30 costæ, about 0.09 to 0.12 mm. apart, between the costæ the surface is more or less transversely minutely wrinkled. Aperture oblique, broad, truncate-ovate, slightly flattened on the dextral side,

forming a blunt angle just above the periphery; usually furnished with very small, low, tubercular, angular and parietal lamellæ, the former often absent; often also with a swelling on the columella. The outer margin of the peristome is slightly expanded, the columellar margin dilated above the umbilicus. Length 1.65, diam. 1.25, aperture (diag.) 0.86 mm.

Oahu: Tantalus (type loc.), near the southern rim of the crater. Exceedingly common on Oahu and Kauai, not common on Maui and Hawaii, rather rare on Lanai and Molokai. Up to the present, no specimens have been reported from Niihau or Kahoolawe.

Holotype 11030, paratypes 22021 Bishop Museum; paratypes 46341 A. N. S. P.

Pupa admodesta Boettger, von Martens' Conch. Mittheil., I, 1880, p. 58, pl. 12, f. 15.

This is one of the most abundant species of *Pupillidæ* found on the Hawaiian Islands. Like *acanthinula*, it is usually taken on the trunks of trees, and on the leaves of shrubs and low-growing plants. Sometimes, and more often than *acanthinula*, it is found on mossy stones, but is rarely taken on dead leaves. It is mostly found in rather damp localities or near streams, from about sea level to 2,000 ft. elevation. In most of the colonies the stock is pure but often it is found in company with its subspecies *spinigera* when the material reaches the collection. Undoubtedly if more care was taken in collecting, the specimens from each individual tree or shrub kept isolated, we would find that the colonies of this species and its variety are of pure stock.

Undoubtedly this is the form described and figured by Boettger as *admodesta*. Boettger does not mention the spine-like processes of the costæ. These are very delicate and fragile, and usually absent, except in fresh specimens. In most of our specimens a large majority of the spines have been broken or rubbed off from being handled while collecting the shells, and extracting the animals.

Specimens with only the angular tooth present are not common and do not occur as a pure form. They are occasionally found among specimens with an angular and parietal lamellæ.

A more common form and one not found in pure colonies has only the parietal lamella developed. The most abundant form is the one selected as the type with both an angle and parietal lamellæ. The angle lamella is present as a very low, indistinct knob, usually slightly separated from the termination of the outer lip. The parietal lamella is about twice as long as its height. In nearly adult specimens the parietal develops before the angle lamella, the latter never appearing except in fully adult specimens. In most adult specimens there is a slight swelling on the inner margin of the columella, which does not appear to develop into a well-defined lamella.

In the embryonic shell of 1½ whorls the early part of the first whorl is immersed, the surface is rather strongly punctate. The points are arranged in rather wavy, transverse rows. The surface of this species is more strongly punctate than that of embryonic specimens of *acanthinula*.

From *acanthinula* it is easily separated by the closer, spine-bearing costæ and the minute parietal and angular lamellæ.

6. *P. b. spinigera* n. subsp. Pl. 1, fig. 11.

The shell is similar to that of *P. boettgeri* but smaller and without any teeth in the parietal wall. Length 1.41, diam. 1.2, aperture (diag.) 0.73 mm. Holotype 11031 Bishop Museum, paratypes 15319 Bishop Museum and A. N. S. P.

This is by far the most abundant form of *Pronesopupa* on the Hawaiian Islands. Several large series are in the Bishop Museum collection, from Kauai, Oahu, Molokai, W. Maui and Hawaii. Up to the present time no specimens have been seen from E. Maui, Lanai, Kahoolawe or Niihau. It is probably common in the first two of these islands but does not seem to have been collected. It is very common under conditions similar to those under which *boettgeri* is found. It is, however, much more abundant and is found more often existing as pure colonies. It is easily recognized by its smaller size and the absence of lamellæ in the aperture.

Embryos taken from specimens from Makiki, Oahu, have a

surface structure slightly more closely punctate than those of the typical form.

Section *Edentulopupa* new section.

Pronesopupæ of 4-4½ whorls, with rather close costæ (35-40 on the last whorl); embryonic whorls, granulose, *minutely spirally striate;* costæ with faint narrow membranous margins. Aperture edentulous. Reproduction ovoviviparous. Type *P. admodesta.*

Distribution: nearly all of the Hawaiian Islands. Specimens have been found from a few hundred feet elevation to nearly 4,000 ft. Most of the specimens were taken on the bark of trees, a few on a stone wall and dead leaves on the ground.

7. PRONESOPUPA ADMODESTA (Migh.). Pl. 1, fig. 13.

"Shell minute, ovate, greenish brown; whorls 3½, convex; incremental striæ very fine; aperture circular, unarmed; lip simple, thin, slightly reflected; umbilicus small. Length 1/20 [1.25 mm.], diam. 1/40 [0.62 mm.] inch. Oahu" (*Mighels*).

Oahu: Nuuanu; Luakaha on stone wall, Glen Ada (Cooke); Tantalus, near edge of crater, on the bark of *lehua* and *koa* trees (Cooke); Waianae Mts. Palehua on dead *ieie* leaves (Cooke); northeast ridge of Kaala (Bridwell). Kauai: Kaholuamanu (Forbes, one specimen). Molokai: Punkolekole (Cooke & Pilsbry) (Cooke); Kalihi (Cooke, one specimen). Hawaii: Hilo (Ancey collection, one specimen).

Pupa admodesta MIGHELS, Proc. Bost. Soc. Nat. Hist., ii, Jan. 1845, p. 19.—PFR., Monographia Hel. Viv., ii, p. 302.—ANCEY, Mem. Soc. Zool. France, v, 1892, p. 708. Not *Pupa admodesta* BOETTGER, in von Martens' Conch. Mittheil., i, 1880, p. 58, pl. 12, f. 15 (= *P. boettgeri*).

Of the numerous forms of *Pronesopupa* found on Oahu, we have selected as typical of *admodesta* the specimens from Luakaha, Nuuanu.

The shell is narrowly umbilicate (umbilicus cleft-like), brownish with a greenish tinge, ovate, costulate, with low, sharp, close, thread-like membranous costæ. Spire with con-

vex outlines, the whorls very convex and separated by a deep suture. Whorls 4, the embryonic (under the microscope) not smooth, irregularly punctate, gradually becoming costulate, the two last whorls costulate. The last whorl ascends slightly near the aperture, is almost evenly ribbed with 35-40 costulæ; these are oblique, rather low, with slightly ragged, thin, membranous outer margins, and of an almost uniform height. The aperture is subcircular, toothless; outer margin expanded, thin, the columella slightly swollen near the middle, but not furnished with a lamella; columellar margin broadly dilated.

Length 1.45, diam. 1, aperture, greatest length 0.67 mm.

The specimens selected for the above description are slightly larger than indicated by Mighels, and also slightly broader in proportion to their length, with a half whorl more. I do not know of any form as small or narrow as Mighels' specimens and he may have made a slight error in his measurements.

Specimens from Tantalus agree essentially with those from Nuuanu, except that the color is a clear light brown, without a greenish tinge, and the aperture is slightly larger without the slight swelling on the inner margin of the columella. One of the specimens measures: length 1.53, diam. 1.04, aperture 0.79 mm.

In embryonic specimens of nearly two whorls the umbilicus is represented by a minute cleft. The first whorl is furnished with a few raised, thin spiral lines, the transverse riblets set in abruptly at the beginning of the second whorl. The raised spiral lines are also found on immature specimens with 3⅔ whorls.

Specimens from Palehua and Kaala, Waianae Mts., are almost duplicates of those from Tantalus, except that the apertures of the Kaala specimens are truncate-ovate rather than subcircular.

A single specimen from Koholuamanu, Kauai, agrees very closely with the specimens from Luakaha in size, color, form and character of costulations. The columella is not, however, slightly swollen near its middle, but uniformly slightly concave.

Altogether four specimens of this species were taken on two trips to Puukolekole, Molokai. They agree very closely in form, color, structure and size of costæ with the Luakaha form. The only material difference is the aperture is larger, with the outer margin of the peristome having a darker tinge. The largest specimen with 4 whorls measures: length 1.53, diam. 1.07, aperture (diag.) 0.8 mm.

A single specimen in the Ancey collection from Hilo, Hawaii, agrees almost perfectly with the Luakaha specimens, the only difference being that the apex is slightly more acute.

Up to the present time no specimens of this species have been reported, as far as is known, from either Lanai or Maui. This species, as determined by us, has not been collected in large numbers in any locality except on Tantalus, Oahu.

Undoubtedly it may sometime prove to be a fairly abundant and widely distributed species on all of the islands, when it is looked for under proper conditions.

Section *Sericipupa* new section.

Pronesopupæ of 5-5½ whorls, closely and evenly costulate, the costæ without membranous margins; embryonic whorls convex, not flattened, very minutely granulose, the granules much finer than in the preceding subgenera. Aperture usually edentulous, occasionally a minute swelling or fold appearing deeply seated on the columella. Type: *P. frondicola.*

Distribution: on the highlands (above 3,000 feet elevation) of Kauai, Molokai, East Maui and Hawaii. Specimens of this section are extremely rare. As far as known all living examples were taken on the leaves of ferns and low-growing shrubs and under the bark and moss of trees.

The sculpture suggests possible descent from *Nesopupilla.*

8. Pronesopupa frondicola n. sp. Pl. 1, fig. 4.

The shell is perforate (umbilicus minute, deep, circular), conic, dresden brown, closely and evenly costulate, rather glossy, thin, subtranslucent. Spire conic with obtuse, rounded summit; whorls convex, separated by a rather deep suture, apex less obtuse than in the preceding forms. Whorls nearly

5¼, increasing very slowly and regularly, the embryonic 1¼ whorls nearly smooth, under a very strong lens very minutely granulose, then, beginning gradually, the rest of the whorls are closely and evenly costulate, the costæ without membranous margins, on the last whorl less than 0.04 mm. apart, the interstices not wrinkled, but under the microscope there are very indistinct, close, short spiral lines perpendicular to the riblets. The last whorl is not very large, tapering towards the base, convex about the umbilicus, ascending slightly near the aperture. Aperture rather small, not diagonal, hardly oblique, toothless, truncate-ovate, lip-insertions remote. Outer margin of the peristome minutely thickened, slightly expanded, columellar margin arched over the umbilicus.

Length 2.05, diam. 1.15, aperture 0.73 mm.

Length 2.1, diam. 1.15, aperture 0.7 mm.

E. Maui: Ainahou, at the head of the Keanae Gap, Haleakala (type loc.) and Halemau, near the head of the Kaupo Gap (Cooke), Ukulele at 6,000 ft. (Forbes, Cooke). On the fronds of living ferns. Holotype 11033 Bishop Museum; paratypes 38486 Bishop Museum and A. N. S. P.

A rather rare species in collections, probably due to the station and the difficulty of finding specimens. All the specimens were found on the pinules of large ferns (*Sadleria*), close to the mid-rib.

Fully adult specimens, from Ukulele, have a minute columellar fold, which is slightly oblique, median in position and situated deep within. These specimens are slightly smaller, and with slightly more convex outlines than those from the type locality. One measures: length 1.95, diam. 1.1 mm.

There is no indication of a columellar fold in any of the specimens from within the crater of Haleakala.

8a. P. frondicola corticicola n. subsp. Pl. 1, fig. 3.

This form is somewhat similar to the typical one. In the subspecies the indistinct spiral lines are slightly more evident under a strong lens and the shell is considerably larger and *stouter*, with the same number of whorls. The figures are drawn to the same scale. The last whorl ascends slightly

more near the peristome than in the typical form. Length 2.32, diam. 1.35, aperture (diag.) 0.92 mm. Holotype 11034 Bishop Museum; paratypes 38785 Bishop Museum and A. N. S. P.

E. Maui: Puunianiau at 7,000 ft. (type loc.), Ainahou and Halemau (Cooke).

All the specimens of this subspecies were taken living in moss on the bark of trees. It appears to be an extremely rare form, but will probably prove to be widely distributed over the mountain of Haleakala.

In an immature specimen with 3½ whorls, the surface structure of the embryonic whorls is fairly well preserved. The surface is minutely granulose, the granules being indistinctly arranged in transverse rows; near the beginning of the second whorl there are faint indications of the rib-striæ as low blunt ridges. The initial portion of the first whorl is immersed with the upper portion of the second whorl forming a distinct blunt ridge bordering the suture.

9. PRONESOPUPA MOLOKAIENSIS n. sp. Pl. 1, fig. 5.

The shell is very like that of *P. frondicola* but slightly smaller, darker colored and narrower in proportion to its length. The aperture is vertical, not slightly diagonal. The surface of the two lower whorls is covered by somewhat coarser costulation, the riblets about 0.07 mm. apart. There is a minute, deeply situated swelling near the middle of the inner face of the columella, as in a few of the specimens of *P. frondicola*. Length 1.96, diam. 1.04, aperture (diag.) 0.73 mm.

Molokai: Kawela, at about 3,500 ft. (type loc.), and Waikolu, about the same elevation; on the leaves of low plants (Cooke). Holotype 41806 Bishop Museum.

Only two examples of this species are known at present, one from each of the localities mentioned above. It is with some hesitancy that we separate the above species from *P. frondicola* of East Maui, under which it might not improperly be placed as a variety. The coarser and more distant costæ, as well as its geographical distribution, are the most important reasons for considering them specifically distinct.

10. PRONESOPUPA INCERTA n. sp. Pl. 1, fig. 6.

The shell is perforate (umbilicus deep, cleft-like), elongate, subcylindrical, buffy citrine, thin, transparent, the surface silky, shining, minutely, coarsely and evenly costulate. The spire is extended, with slightly convex outlines, the individual whorls convex, separated by a rather deep suture, apex slightly acute. Whorls 5, increasing slowly and regularly, the embryonic, under the microscope, minutely granulose, with costulæ beginning at about the middle of the second whorl; the rest of the whorls evenly and regularly costulate; riblets without membranous edges, on the last whorl about 0.07 mm. apart; the interstices very minutely granulose; last whorl rather large, convex, tapering towards the base, scarcely ascending near the aperture. Aperture toothless, truncate-oval, hardly oblique, nearly perpendicular, the lip-insertions remote, connected by a thin callus. Outer margin of peristome slightly thickened, hardly expanded; columellar margin thickened along its edge, arched above the umbilicus, its inner face nearly straight. Length 1.78, diam. 1.02, aperture (diag.) 0.67 mm.

Kauai: Halemanu (Cooke). Holotype 15467 Bishop Museum.

As far as known but two specimens of this species have been taken up to the present time. Both specimens were found on the ground on dead leaves, probably shaken from the fronds of ferns. Each came from a different locality near Halemanu. Unfortunately, no immature specimens are at hand to make out clearly the surface structure of the embryonic whorls, as in both specimens the apices are considerably eroded. The second specimen is lighter in color than the type, with more compact whorls, slightly smaller, with more convex outlines. It has 5 whorls and measures: length 1.71, diam. 1.02, aperture (diag.) 0.64 mm.

This species is easily recognized from its other relations by its smaller size and slight difference in color. Under a strong lens no spiral striation could be made out in either specimen. At first glance it appears to be closely related to *P. admodesta*, but is easily separated by its acute and ex-

tended apical whorls and the absence of membranous edges to the riblets.

11. PRONESOPUPA SERICATA n. sp. Pl. 1, fig. 1.

The shell is perforate (umbilicus minute, circular, deep), nearly cylindric, dresden brown, thin, slightly translucent, the surface silky, closely and evenly costulate. Spire extended, with slightly convex outlines, the whorls convex, separated by a rather deep suture. Apex relatively acute. Whorls 5½, increasing very slowly and regularly, the embryonic, under the microscope, minutely granulose, then, beginning gradually, the rest of the whorls are closely and evenly costulate; the riblets low, without membranous edges, on the last whorl about 0.05 mm. apart, and, under a very strong lens, crossed by minute, close, indistinct, raised spiral lines, and with minutely granulose interstices. Last whorl slightly broader than the penult, long, tapering towards the base, convex around the umbilicus, slightly ascending near the aperture. Aperture unarmed, hardly oblique, not diagonal, nearly vertical, narrowly truncate-ovate, the lip-insertions remote. Outer margin of the peristome indistinctly thickened, not expanded, columellar margin triangular, arched above the umbilicus, its inner face straight. Length 2.7, diam. 1.41, aperture (diag.) 1.04 mm. Holotype 11035 Bishop Museum; paratypes 39256 Bishop Museum and A. N. S. P.

Hawaii: Piihonua, (a hill) in the flow of 1855, about 5,000 feet elevation, on leaves (type loc.); Humuula and Kipuu, in 1880 flow, above 6,000 feet (Forbes).

A very rare and interesting species from the highlands of Hawaii. All the specimens were taken by Mr. Forbes and were found on the leaves of plants. The type material consists of two adult (one of which is badly broken) and four immature specimens. There are but two specimens from each of the other two localities.

This species is most closely related to *P. f. corticicola* from Maui. It differs, however, in its more extended spire, less convex outlines and especially in its coarser and more strongly costate surface.

12. Pronesopupa lymaniana C. & P., n. sp. Pl. 1, fig. 2.

The shell is similar to that of *P. sericata*, but shorter, broader in proportion to its length, more pupiform and with more convex outlines. The individual whorls are less convex and consequently the suture is not as deep. Whorls 5, the embryonic slightly smoother and less granulose than those of *P. sericata*, the rest of the whorls evenly and closely costulate, the interstices very minutely granulose, spiral striation hardly showing under the microscope. The last whorl ascends slightly near the aperture. The aperture is nearly vertical, truncate-ovate. The outer margin of the peristome is very slightly thickened, not expanded. The inner face of the columella is straight. Length 2.08, diam. 1.22, aperture (diag.) 0.8 mm.

Hawaii: 28½ miles Olaa road (Lyman). Type 12516 Bishop Museum; paratypes in Bishop Museum and A. N. S. P.

A very rare species of which there are only four specimens in the Bishop Museum, from the original series collected by Mr. E. Lyman.

It is distinguished from *P. sericata* by its smaller size, more convex outlines and less convex individual whorls; and from *P. frondicola* it is most easily recognized by its broader pupoidal form and less convex whorls.

13. Pronesopupa orycta C. & P., n. sp. Pl. 1, fig. 10.

The shell characters are somewhat similar to those of both *sericata* and *lymaniana*. The shell is narrow, subcylindrical, with an extended spire and with the apex relatively acute. Whorls 5½, the embryonic slightly more projecting than in the other species, very minutely granulose, the rest closely coiled, slightly convex, the last rather large, ascending slightly near the aperture, tapering towards the base. The riblets of the last whorl are from 0.055 to 0.07 mm. apart. Aperture small, toothless, truncate oval. Outer margin of peristome minutely thickened, very slightly expanded; columellar margin arched above the umbilicus, its inner face slightly concave. Length 2.02, diam. 1.1, aperture (diag.) 0.73. Type

11036 Bishop Museum; paratypes 36653 Bishop Museum, A. N. S. P. and Thaanum coll.

Hawaii: Fossil at Palihoukapapa (Thaanum).

There are but four specimens of this interesting little form in the Bishop Museum.

There is no doubt but that the three forms from Hawaii, considered here as species, might be united under a single specific name and be given varietal rank. They are, however, easily recognized from one another with an ordinary hand lens and are without any intermediate connection such as occur on Maui, and with our present knowledge it seems best to consider them as separate species.

Undoubtedly this genus is widely distributed on the highlands of Hawaii, and there are probably many forms, if not species, left to the patient collector of these practically (from a conchological standpoint) unknown fields.

Genus PUPISOMA Stoliczka.

Pupisoma Stol., Journ. Asiatic Soc. Bengal, xlii, 1873, p. 32, type *P. lignicola*.—Pilsbry, Man. Conch., ix, p. 52.—Godwin-Austen, Land and Freshwater Moll. India, ii, 1910, p. 300.—*Ptychopatula* Pilsbry, Proc. A. N. S. Phila. 1889, p. 191; Nautilus, iii, p. 62; Man. Conch., ix, pp. 54, 57, *H. cæca* Guppy designated as type.

The shell is ovate or globose-conic with obtuse apex, usually perforate, thin; whorls 3½ to 5½, strongly convex. Aperture truncate-rounded; peristome thin, slightly or not expanded, the columellar margin dilated and reflected.

Animal viviparous, having short eye-stalks and no inferior tentacles. Jaw composed of vertical plaits with narrow intervals. Radula with tricuspid central teeth; lateral teeth tricuspid (*miccyla*) or with the inner cusp suppressed (*dioscoricola*); marginals with 4 or 5 unequal cusps; formula 14.1.14 (*dioscoricola*) or 15.1.15 (*miccyla*).

Distribution, tropical and subtropical regions of both hemispheres except in arid districts and oceanic islands; living on the bark and leaves of trees and other plants.

As to the systematic position of *Pupisoma* opinions have

varied. Stoliczka and Blanford thought it a subdivision of Pupa, having in mind the larger species, *lignicola* and *evezardi*. Von Moellendorff, who knew only *orcula*-like species, referred it to what he considered the Fruticicolid group, in the neighborhood of *Acanthinula* and *Zoogenites*. Later estimates were less sagacious. The present writer placed it in the *Endodontidæ*, but expressed a suspicion that it might belong to *Pupidæ*. Finally Godwin-Austen placed it in the subfamily *Thysanotinæ* of the *Endodontidæ*.

In restoring the genus to the *Pupillidæ*, and placing it in the subfamily *Vertigininæ*, the writer has been influenced chiefly by the identical type of teeth and the absence of inferior tentacles. Moreover, the shell, in the type species, *P. lignicola*, approximates closely to such Nesopupæ as *N. barrackporensis* in sculpture, and is utterly unlike any Endodontid snail. The teeth of the shell of *P. lignicola*, such as they are, are normal for a Pupillid snail, but not like any Endodontid. The genus may be regarded as an arboreal derivative of *Nesopupa*, which has been modified like the Hawaiian Pronesopupæ (likewise arboreal or folicolous) by decadence or loss of teeth in the aperture, simplification of the peristome and increasing tenuity of the shell.

P. dioscoricola in America and *P. orcula* of the Oriental fauna are so similar that transportation by commerce seems possible or even likely; yet other and strongly differentiated forms show that various species are certainly indigenous in both hemispheres. Former communication of the herds may have been around the north Pacific.

Pupisoma comprises about a dozen well-established species, divided between America and the Old World. As many more doubtful or nominal species have been described by authors who knew little or nothing of previous work, or who did not compare their supposed novelties with the widespread *P. dioscoricola* and *P. orcula*. There has been no general revision of the genus hitherto, and its species have been scattered through several genera.

Minute snails such as *Pupillidæ* and *Valloniidæ* frequently occupy far greater areas than the associated larger land mol-

lusks; but there is good reason for the belief that the normal areas of some Pupisomas have been extended by commerce. Living on the bark and leaves of a great variety of shrubs and trees, some of them such as oranges and palms, widely cultivated, these snails must often be transported to remote gardens in different parts of the world. Burnup considers the South African species to be such involuntary immigrants. Possibly the New Caledonian and Queensland forms may also be expatriated species from India or elsewhere. However, the details of distribution of *Pupisoma* are as yet little known in South America, tropical Africa, the East Indies, and even India.

Besides the widely-spread species *dioscoricola* and *orcula*, there are various more local species in America and Asia.

In America the only group which could well be thought related to *Pupisoma* is *Bothriopupa*. This genus has been placed in the Gastrocoptinæ (Vol. XXIV, p. 226), but with some doubt. If the animal proves to lack lower tentacles, as I suspect, it will be transferred to the subfamily Vertigininæ, in the neighborhood of *Nesopupa*. It is possible that the pitted-granulose American Pupisomas are simplified, folicolous derivatives from a Bothriopupid ancestral stock. Observations on the living animals of these snails will bring the several hypotheses of their affinities nearer the earth.

Some Thysanophoras resemble *Pupisoma;* yet upon going over the shells carefully there is no serious difficulty in making the distinction. *P. dioscoricola*, under various names, has hitherto been referred to *Thysanophora* or *Acanthinula*.

Pupisoma as now accepted contains three sections which appear related by shell characters.

I. *Pupisoma* proper. Shell ovate, somewhat pupiform, of 4½ to 5 whorls, minutely pitted-granose; columella thickened, obliquely truncate or indistinctly toothed. *P. lignicola, P. evezardi;* both Indian.

II. In a tropical American group the shell is minutely pitted-granose, otherwise like *Ptychopatula*. Species, *P. macneilli, P. minus, P. mediamericanum*. The sculpture resem-

bles that of the typical Pupisomas, some Nesopupæ and *Bothriopupa*.

III. *Ptychopatula* Pils. Shell globose-conic, of 3½ to 4 whorls, striate or irregularly ribbed, usually with *spiral lines;* columella concave, simple, the columellar margin dilated. *P. dioscoricola, P. orcula* and their allies, East and West.

Old World Species.

The sculpture has been imperfectly described in some of these species; the following key may, therefore, require revision.

I. Shell decidedly higher than wide, of 4½ to 5 whorls; surface microscopically granose-pitted; columella obliquely truncate below II
Shell but little higher than wide, or not so, of 3 to 5 whorls; surface striate; columella continuously curving into basal lip III

II. Pale gray; 2 to 2.15 mm. long; Burma.
P. lignicola, no. 1.
Brown; 2.25 to 2.63 mm. long; Western Ghats.
P. evezardi, no. 2.

III. Peristome thickened and reflected; a varix on the last whorl; perforate; alt. 2.2, diam. 2.1 mm.; 5 whorls. Andaman Is. .....*P. constrictum,* no. 6.
Peristome simple; no varix IV

IV. Surface without spiral lines V
Surface having microscopic spiral lines; very narrowly perforate VII

V. Imperforate; species of Ceylon VI
Umbilicus about one-seventh the width of the shell; alt. 1.2, diam. 1.16 mm. to 1.55 x 1.45 mm.; 3½ whorls .....*P. japonicum,* no. 3.

VI. Surface striatulate; alt. 1.5, diam. 1 mm., 4 whorls.
P. miccyla, no. 4.
Surface costulate; 3 whorls .....*P. longstaffi,* no. 5.

VII. Alt. 1, diam. 1.3 mm., 4 whorls; striatulate, Borneo.
P. pulvisculum, no. 9.

Alt. 1.5, diam. 1.33 mm., closely ribbed; Silchar.
P. cachariсum, no. 8.
Larger, up to 2 x 2mm.; 3½–3⅔ whorls VIII
VIII. Thread-striate; Penang .....*P. orcella*, no. 7.
Irregularly, finely striate; Japan to S. Africa and New Caledonia .....*P. orcula* and allies, nos. 9-15.

1. PUPISOMA LIGNICOLA (Stoliczka). Pl. 2, figs. 7, 10.

Shell shortly swollen-ovate, subconic, corneous, slightly rimate, the apex obtuse. Whorls 4½, a little convex, covered with moderately distant, transverse, slightly arcuate riblets alternating with some finer striæ, becoming obsolete at the base. Aperture subrotund; labium [parietal wall] very thin; very rarely furnished with a small median denticle; outer lip thin, very little dilated, toothless, slightly ascending on the penult whorl. Columella slightly expanding towards the base, covering the umbilical region, twisted, somewhat toothed below. Alt. 2, diam. 1.5, min. 1.2 mm. (*Stol.*).

Burma: Moulmein, Tenasserim, on masonry of the great Pagoda, and on the opposite bank of the river at Martaban on similar wooden structures (Stoliczka). Kangan caves, near Moulmein (Stoliczka, Nevill). Rangoon (Hungerford).

Pupa lignicola STOL., Journ. Asiat. Soc. Beng., xl, 1871, p. 171, pl. 7, f. 3.—HANLEY and THEOBALD, Conch. Indica, pl. 160, f. 6.—*Pupa (Pupisoma) lignicola* STOL., J. A. S. B., xlii, p. 32. — NEVILL, Handlist Ind. Mus. Moll., i, p. 192. — *Pupisoma lignicola* GODWIN-AUSTEN, Land and Freshwater Moll. India, ii, 1910, p. 300.—GUDE, Fauna Brit. India, Moll., ii, p. 34.

"The animal is grey with somewhat darker, very short pedicles and almost obsolete tentacles. The columella of the shell is at the base peculiarly expanded, flattened, somewhat twisted, producing at the lower part a small denticle. Out of a great number of specimens only one was met with which has a small tooth about the middle of the inner or parietal lip; its presence, therefore, must be regarded as an exceptional character" (*Stoliczka*).

The riblets mentioned by Stoliczka are partly cuticular

and liable to be rubbed off, leaving white lines. Their development is uneven, and on some specimens they would hardly be noticed. Under the microscope the surface appears densely pitted-granulose, exactly as in some Nesopupas. All adult shells have a low columellar tooth, and one of those before me from Moulmein (fig. 7) has a small, short parietal lamella (mut. *unidentata* Godwin-Austen). The basal lip expands somewhat, the outer lip scarcely so, but though thin it has a smooth finish. It is more Pupiform than the other species. Moulmein examples are figured. They measure;

Length 2.15, diam. 1.5 mm.; 4⅔ whorls.

Length 2.1, diam. 1.5 mm.; 4½ whorls.

2. Pupisoma evezardi (Blanford). Pl. 2, figs. 8, 9.

"Shell imperforate, with scarcely even a trace of rimation in the umbilical region, conoidly ovate, thin horny, with raised hair-like oblique lines, rather irregularly disposed, on all the whorls. Spire nearly cylindrical below, conoidal above, the sides convex, apex blunt, suture impressed. Whorls 4½, convex, increasing in size regularly; the last but little larger than the penultimate, rounded at the periphery and below, not descending in front. Aperture diagonal, nearly circular, but truncated above, without teeth; peristome thin, all in one plane, slightly expanded, margins converging; columellar vertical above, slightly twisted below, reflected and united to the whorl so as completely to cover the umbilicus. Length 0.11, diameter 0.08, length of aperture 0.04 inch" (*Blanford*).

Length 2.63, diam. 1.8 mm.; 5 whorls.

Length 2.25 mm.

India: Karkalla, near Kandalla, at the head of the Borghat, Bombay Presidency (Col. Evezard).

Pupa (Pupisoma) evezardi W. T. Blanford, Journ. Asiatic Soc. Bengal, xlix, 1880, p. 199.—Hanley & Theobald, Conchologia Indica, 1875, p. 41, pl. 101, f. 5, 6.—*Pupisoma evezardi* Godwin-Austen, Land and Freshwater Moll. India, ii, 1910, p. 301.—Gude, Fauna of British India, ii, p. 37.

There is but little difference between this species of the

Western Ghats and *P. lignicola* of Burma, though the localities are so remote. Both have the same microscopic, in places vermiculate granulation, with delicate striæ and partly cuticular, low, widely-spaced riblets, and the same broad, short columella, obliquely truncate below. *P. lignicola* has the pale gray tint usually called "corneous", while *evezardi* is much darker, nearly walnut-brown. Some specimens of the latter species are larger than any *lignicola* seen.

Blanford discredits the locality "Singhur, Deccan" given by Hanley and Theobald, suspecting that the specimens figured were from Colonel Evezard's original lot. Godwin-Austen and Gude merely quote Blanford. Nobody seems to have seen the characteristic granulation. The specimens figured were collected by Maj. A. Peile, R.A., in the Western Ghats, probably near the original locality.

Group of Pupisoma orcula.

No less than eleven species of the *orcula* type have been described from points between Abyssinia, Annam and Australia; but in most cases no comparison was made with any other species. Though several forms are represented in our collection by topotypic material, the general comparisons needed cannot be made until much more typical material is available to one observer. It appears likely that *P. orcula* will be found to include *hueensis, philippinicum, pulvisculum, circumlitum, vimontianum, steudneri* and possibly *cacharicum.*

3. Pupisoma japonicum Pilsbry. Pl. 2, figs. 11, 12.

The shell is globose-conic with obtuse summit, umbilicate (the width of umbilicus contained about 7 times in diam. of shell), fragile, pale brownish or olive-buff, delicately striatulate but *without spiral lines.* The whorls are rather strongly convex. Aperture oblique, peristome thin and fragile, the columellar margin broadly expanded and reflected. Length 1.55, diam. 1.45 mm.; 3½ whorls.

Japan: Hirado, Hizen; Kashima, Harima (Hirase). South Africa: Maritzburg, Edendale, Karklooff and Ntimbankulu, Natal, commensal with *P. orcula* on indigenous trees and shrubs (Burnup).

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Pupisoma japonicum Pils., Nautilus, xvi, June 1902, p. 21. —Hirase, The Conchological Magazine, iii. p. 26, pl. 9, f. 32, 33. — Burnup, Proc. Malac. Soc. London, x, 1912, p. 46.— Connolly, Ann. South African Mus., xi, pt. 3, p. 159, right figure.

The small size, total absence of spiral striation, and the umbilicus, relatively larger than in any known Oriental species, distinguish this shell. Like *P. orcula*, it is viviparous. Burnup gives the following measurements of apparently mature South African specimens:

Height 1.22, diam. 1.16 mm.; per cent of alt. to diam. 105.
Height 1.32, diam. 1.24 mm.; per cent of alt. to diam. 106.
Height 1.35, diam. 1.32 mm.; per cent of alt. to diam. 102.
Height 1.41, diam. 1.37 mm.; per cent of alt. to diam. 103.

Pupisoma japonicum depressum Pils. (pl. 2, fig. 13) is similar to *japonicum* except that the whole shell is a little more depressed, the diameter slightly exceeding the altitude. Length 1.3, diam. 1.35 to 1.4 mm.; alt. 92 to 96 per cent of the diameter.

Japan: Mikage, Settsu (Hirase).

Pupisoma japonicum depressum Pils., Proc. A. N. S. Phila., 1905, p. 710.—Hirase, Conch. Mag., iii, p. 26, pl. 9, f. 34.

4. Pupisoma miccyla (Benson). Pl. 3, figs. 1, 2, 3.

Shell imperforate, globosely conoid, thin, striatulate, a little shining, brownish-corneous, translucent. Spire truncate-conic; suture impressed, the apex very obtuse. Whorls 4, convex, the last globose, slowly descending in front. Aperture lunate-rounded, oblique, the peristome acute, right margin arcuate, columellar margin acute, vertical, forming nearly a right angle with the basal margin.

Length 1.5, diam. 1 mm. (*Bens.*).

Length 1.53, diam. 1.1 mm. (Godwin-Austen).

Ceylon: Matelle, on the bark of an orange tree (F. Layard). Binoya Estate, Watawala, on the bark of mango and orange trees (Collett).

Helix miccyla Bens., Ann. Mag. N. H. (3), v, May 1860, p. 384.—Hanley & Theobald, Conch. Indica, 1875, pl. 129, f. 8,

9. — *Pupisoma miccyla* GODWIN-AUSTEN, Land and Freshwater Moll. India, ii, 1910, p. 301, pl. 132, f. 1–1*b* (shell), 1*c*, 1*d* (teeth and jaw). — GUDE, Fauna British India, Moll., ii, p. 38.

"Allied to *H. orcula* of northeastern India, but smaller, destitute of the peculiar sculpture of that species, and distinguished by its very obtuse apex and by the formation of the columellar lip" (*Benson*).

Godwin-Austen's figures are copied. He writes as follows: "Nearly every animal examined contained three embryonic shells, some in an advanced stage of development, showing the apex of the shell; compared with the parent animal they are very large, and being pale-colored were very apparent. During the height of the rains they must be extremely prolific, and no doubt are crowded in colonies together, as I have seen some species, such as *Georissa*, etc., in the humid valleys of the Khasi Hills. Mr. Collett took them off orange trees in September, 1899, in the bungalow garden on the Binoya Estate."

5. PUPISOMA LONGSTAFFI Godwin-Austen. Pl. 3, fig. 11.

"Shell imperforate, very globosely conoid; sculpture a smooth epidermis, with very fine, somewhat distant costulation; color pale brown; spire depressedly conoid, apex blunt, suture impressed; whorls 3, very tumid and well rounded on the periphery. Aperture nearly circular; peristome thin; columellar margin thickened and slightly reflected and extending as a callus on to the last whorl (*G.-A.*).

Ceylon: Kandy, on palm tree (Mrs. J. Longstaff).

Pupisoma longstaffi G.-A., Land and Freshwater Mollusca of India, ii, pt. xi, March 1910, p. 303, pl. 132, f. 3–3*b*.—*Pupisoma longstaffi* G.-A., GUDE, Fauna British India, Moll., ii, p. 39.

"This shell is more globose than *P. miccyla* and not so high in the spire, which tapers more rapidly. It is also costulate as in the *Pupisoma* figured on plate 132, fig. 2, a single specimen of which was sent to me by Mr. Sykes, and cannot now be found. Mrs. Longstaff writes: 'Numerous on palm, Flor-

ence Hotel Garden, Kandy. Animal, body light grey, only one pair of tentacles, dark. Tail pointed.'

"I was fortunate in seeing the radula in the first specimen I examined. Nothing could be seen of the genitalia. The mantle zone was simple, with no shell-lobes. There are not many teeth in the row, only some 15 or 16; all are large quadrate plates. The central tricuspid, the admedians and laterals bicuspid, the inner cusp long, the outer small and basal. The jaw was crumpled up, and being so minute was not well seen, but it appeared to be smooth. I am much indebted to Mrs. Longstaff for placing this species in my hands and I have named it after its discoverer" (*G.-A.*).

6. PUPISOMA CONSTRICTUM (Godwin-Austen). Pl. 3, figs. 8, 9, 10.

Shell turbinate, perforate; sculpture minutely costulate above, from the swollen portion forwards the surface is smoother; color, pale ochraceous; spire conic; sides flat; apex pointed; suture impressed; whorls 5, convex, at the distance of half a turn in the spiral behind the aperture there is a sharp swelling of the whorl, marking apparently the position of the previous aperture, but this is not seen in any of the whorls above; aperture ovate, oblique, peristome much thickened and reflected, united by a thin callus on the body-whorl; sinuate below and on outer margin. Maj. diam. 2.1; alt. axis 2.2 mm. (*G.-A.*).

Andaman Is.: South Andaman (de Roepstorff).

Pupa (Pupisoma) constrictus G.-A., Proc. Zool. Soc. Lond., 1895, p. 450, fig. B. — *Pupisoma constrictum* G.-A., GUDE, Fauna Brit. India, Moll., ii, p. 35, f. 11.

"Animal not yet seen, and it is difficult to say where this species should find generic position. I sorted out from a tube full of minute shells eight specimens of this very curious and interesting species. Its sculpture is like that of *Pupisoma lignicola* Stol., from Moulmein, and I think it better to place it near this than to create a new genus for it, which I at first intended. I think it is best, however, to wait until some one else can examine the animal" (*G.-A.*).

It should be noted that some other species of *Pupisoma* show resting stages comparable to the swelling noticed in this one. It is a character of old age, and probably not in itself of specific significance.

7. Pupisoma orcella (Stoliczka). Pl. 3, figs. 5, 6, 7.

Shell subglobose-conoid, at apex obtuse, very narrowly perforate, thin, corneous; whorls 3½, strongly convex, joined by a simple suture, transversely thread-striate. Aperture subrotund, a little oblique, toothless; outer margin very thin, scarcely spreading; columellar margin whitish, slightly twisted, reflected above, almost wholly covering the umbilicus. Alt. 1.7, diam. 1.25, alt. aperture 0.6 mm. (*Stoliczka*).

Penang, under bark of *Cocos nucifera* (Stol.).

Pupa (Pupisoma) orcella Stol., Journ. Asiat. Soc. Beng., xlii, 1873, p. 33, pl. 2, f. 2.

"The animal is gray with dusky pedicles but no perceptible trace of tentacles. The species differs from *P. lignicola* by a shorter and broader form, more convex whorls, and by a very slightly expanded and thin outer lip. In fresh specimens some of the transverse striæ of the cuticle are rather stronger than others, but they very soon wear off" (*Stoliczka*).

Stoliczka's figures are copied, pl. 3, figs. 5, 6. A Penang specimen believed to belong to this species is drawn in fig. 7. It measures, alt. 1.9, diam. 1.65 mm., nearly 4 whorls. The umbilical crevice is very minute. The surface has rather sharp though low and unequal striæ, and under the microscope shows engraved spiral lines, distinct on the base but elsewhere faint.

8. Pupisoma cacharicum Godwin-Austen. Pl. 3, fig. 4.

"Shell scarcely perforate, globosely conoid, very tumid, corneous; sculpture, spiral striation, crossed by a fine, close, thread-like ribbing; color, pale umber-brown; spire moderately high, conic; apex blunt; suture open; whorls 3½, rapidly increasing, very convex; aperture nearly circular, oblique; peristome thin, columellar margin perpendicular reflected. Major diam. 1.33; alt. 1.5 mm." (*G.-A.*).

India: Silchar (J. Wood-Mason).

Pupisoma cacharica G.-A., Land and Freshwater Mollusca of India, ii, part xi, March 1910, p. 303, pl. 132, f. 4.—*Pupisoma cachariсum* G.-A., Gude, Fauna Brit. India, Moll., ii, p. 39.

"The tube containing some 50 shells was wrapped up in a piece of paper, on which was written the following notes: 'From the branches of a Pepul tree, in scars and other shallow cavities, opposite the Deputy Commissioner's Cutchery, Silchar, 3.4.'81.

" 'Only one pair of short, thick, blunt, sausage-shaped tentacles, at the upper extremity of which the black eye-spots are placed. Animal semitransparent, greyish, milky white below, above grey; retractor muscles of tentacles very plainly visible through integument. No tail-gland.' Sent to me for determination by Dr. N. Annandale, from the Indian Museum. The type-shell figured, with the remaining specimens, will be returned to that Museum" (*G.-A.*).

Godwin-Austen does not make any comparison with *P. orcula*, which is a little larger, but otherwise seems similar.

9. Pupisoma pulvisculum (Issel). Vol. III, pl. 42, figs. 55-57.

Shell very minute, nearly covered perforate, corneous-buff, translucent, obliquely striatulate under a strong lens. Spire convexly conoid, the apex flattened; whorls 4, convex, separated by a deep suture, the last whorl descending a trifle to the aperture, convex at base. Aperture strongly oblique, subangular at base; peristome acute, the right margin regularly semicircular, columellar margin nearly vertical, somewhat straight, delicately reflected at the insertion. Alt. 1, diam. 1⅓ mm.; length of aperture ¾ mm. (*Issel*).

Borneo: State of Sarawak (Beccari); Labuan (Everett). Lombock, 1200 ft., on fruit trees (Everett).

Helix pulvisculum Issel, Ann. Mus. Cir. Stor. Nat. di Genova, vi, 1874, p. 406, pl. 5, f. 24-27.—Tryon, Man. Conch., iii, p. 191.—*Pupisoma pulvisculum* (Issel) E. A. Smith, Proc. Malac. Soc. Lond., iii, p. 29.

Possibly distinct from *P. orcula* by having 4 whorls in a shell of smaller size, if the measurements are correct. Noth-

ing is said of spiral striæ, but these have been overlooked by some other describers of *Pupisoma*. Issel's figures having been copied in a former volume are not repeated here.

10. PUPISOMA ORCULA (Benson). Pl. 2, figs. 1, 2, 3, 4, 5.

Shell slightly perforate, conic-globose, corneous, translucent, scabrous, obliquely irregularly costulate-striate. Apex obtuse. Whorls 3½, convex, the last rounded, suture deep. Aperture oblique, rounded, scarcely as long as the spire; peristome thin, acute, the columellar margin reflected, half covering the perforation. Diam. 2, axis 2 mm. (*Benson*).

Length 2.05, diam. 2 mm.; 3½ whorls (Kyoto, Japan).

Length 1.8, diam. 1.75 mm.; 3½ whorls (Maritzburg).

Japan: Kyoto, Yamashiro (Hirase).

India: Between Jounpore and Benares, on trunks of mango trees (Lieut. Burkinyoung); Dinapur, near Patna and in mango groves from Barrackpur, in Bengal, to the borders of Sikkim and thence to Chuprah in Bahar (Dr. J. F. Bacon).

Java (Burnup); Philippines; Savu I. (near Timor) (A. N. S. P.).

South Africa: Cape of Good Hope at Port Elizabeth (Crawford) and Grahamstown (Farquhar). Natal: Maritzburg, Ntimbankulu, Dargle, Edendale, Game Pass (Burnup); Richmond (Wakefield, Cooper); Karkloof (Taynton). Pretoria, Transvaal (Connolly). Victoria Falls, Rhodesia (Warren).

Helix orcula BENSON, Ann. Mag. N. H. (2), vi, Oct. 1850, p. 251. — REEVE, Conch. Icon., vii, 1853, pl. 174, f. 1176.— PFEIFFER, Conch. Cab., Helix, iii, 1854, p. 357, pl. 136, f. 18. —HANLEY & THEOBALD, Conch. Indica, 1874, pl. 87, f. 1, 4.— *Pupisoma orcula* (Bens.), GODWIN-AUSTEN, Land and Freshwater Moll. India, ii, 1910, p. 301.—HIRASE, Conchol. Magazine, iii, 1909, p. 26, pl. 9, f. 30, 31.—BURNUP, Proc. Malac. Soc. Lond., x, 1912, p. 45.—CONNOLLY, Ann. S. African Mus., xi, 1912, p. 159, left fig.

The oblique striæ are unequal and irregularly spaced. Under the microscope impressed spiral lines are seen, weak

above, but distinct on the base. They are rather distinct throughout in the specimen figured from Bohol. They are never so clearly cut as in some *P. dioscoricola,* but the least striate *dioscoricola* are not distinguishable from many specimens of *orcula.*

Specimens (pl. 2, fig. 4) perhaps referable to *P. pulvisculum* are before me from Bohol, Quadras coll. They are clean, light pinkish cinnamon-colored, finely and sharply striate, larger striæ at rather close intervals, and very distinctly striate spirally. Umbilicus about as in *orcula.*

Alt. 1.6 to 1.65, diam. 1.55 mm.; 3⅔ whorls.

Cebu specimens (pl. 2, fig. 3) are noticed below under *P. philippinicum,* which appears to be merely *orcula.*

"In Natal the shells are found on the trunks, branches and leaves of *Cussonia* and other native shrubs and trees in woods, as well as on orange and apple trees in orchards." "Sometimes a distinct varix, showing a former resting-place, is formed upon the shell" (*Burnup*).

Mr. Burnup has pointed out that old shells become proportionately higher for their diameter than younger. He gives the following measurements of South African specimens which seem mature:

Alt. 1.57, diam. 1.75 mm.; per cent of alt. to diam. 90.

Alt. 1.62, diam. 1.88 mm.; per cent of alt. to diam. 86.

Alt. 2.00, diam. 1.74 mm.; per cent of alt. to diam. 115.

Alt. 2.18, diam. 1.94 mm.; per cent of alt. to diam. 112.

"Both this species and the following [*P. japonicum*] are ovoviviparous, many of the specimens examined containing one young mollusk furnished with a shell, and some few containing two, one much larger than the other."

Pl. 2, fig. 2 represents a specimen from Maritzburg.

This species is thought by Burnup to be an importation by commerce; yet as a similar form, perhaps identical, occurs in Abyssinia, it may turn out to be one of the generally distributed East African snails, now known only at its northern and southern limits.

P. orcula appears to be so widely spread in the Oriental Region and *P. dioscoricola* in the Neotropical that one hesi-

tates to question their endemicity in both hemispheres; yet the possibility of transportation by commerce is not to be ignored.

The following forms, *hueense, philippinicum, pulvisculum* (no. 9), *circumlitum* and *steudneri* appear to be synonyms. Further material may perhaps reveal differences; I have seen typical material of *philippinicum* and *circumlitum* only, and it is hardly safe to synonymize the others without knowledge of the microscopic sculpture, which the descriptions do not give. The original descriptions follow.

11. *Pupisoma hueense* (Wattebled). Pl. 3, fig. 12.

Shell very minute, subrimate, conic, thin, somewhat pellucid, slightly striate, somewhat greenish-corneous. Spire turbinate, the apex obtuse. Suture impressed. Whorls 3½, gradually increasing, strongly convex. Aperture oblique, subrotund. Peristome simple, dirty whitish, the columellar margin a little thickened, outer margin acute. Alt. 2, diam. 1½ mm. (*Wattebled*).

Annam: Hué, under dead leaves in thickets (Dorr).

Helix hueensis Wattebled, Journ. de Conchyl., vol. 34, 1886, p. 57, pl. 4, f. 3.

Not seen. Probably a synonym of *P. orcula.*

12. *Pupisoma philippinicum* Mlldff. Pl. 2, figs. 3.

Shell rimate, globose-conoid, thin, finely striatulate, corneous; spire convexly conic, the apex obtuse. Whorls 4, quite convex, the last rounded, slightly descending in front. Aperture diagonal, subcircular; peristome thin, very slightly expanded, the columellar margin dilated, triangularly reflected. Alt. 2, diam. 1.7 mm. (*Mlldff.*).

Philippines: Montalban and Manila, Luzon (Moellendorff). Cebu, on bushes and shrubs (Koch). Moluccas: Hitulama, northern Amboyna (A. Strubell). Savu I., on orange trees (Everett). Caroline Is.: Ponape (Kubary).

Pupisoma philippinicum Moellendorff, Nachr.-bl. d. Malak. Ges., xx, Aug. 1888, p. 108. — Journ. of Malacology, vii, 1898, p. 111; Bericht Senck. Nat. Ges., 1890, p. 223, pl. 8, f. 4.—Boettger, same Bericht, 1891, p. 268.

The type was sieved out of earth from Montalban. "The Philippine species is somewhat higher [than *P. orcella*], the whorls are not so convex, the striation somewhat finer."

The Cebu form has weaker striation, according to Moellendorff. His figures were copied in Vol. IX, pl. 14, f. 43, 44, and a Cebu specimen is drawn in pl. 2, fig. 3. Length 1.85, diam. 1.8 mm.; 3⅔ whorls. It has spiral striation like that of *P. orcula,* and the specimens seem to differ in no way from that species.

13. *Pupisoma circumlitum* Hedley. Pl. 3, figs. 14, 15, 16.

"Shell globose-conical, perforate, thin, translucent. Color a uniform pale tawny-olive. Whorls three and a half, well rounded; suture impressed. Sculpture: everywhere the whorls are crossed by fine, close, raised hair lines; at irregular intervals these tend to rise into lamellæ, which latter can scarcely be detected in profile on the periphery; the embryonic shell is similarly sculptured, no trace of spiral sculpture can be seen; a break at the completion of the second whorl suggests that here ends the nepionic shell. Umbilicus minute, funnel-shaped, showing only the preceding whorl. Aperture very oblique, ovate-lunate, lip simple, columellar margin broadly reflexed over the umbilicus, callus thin, transparent. Height 1.9, breadth 2 mm." (*Hedley*).

Length 2.15, diam. 2.1 mm. Paratype.

Queensland: Bundaberg, on trees (Dr. May); near Grafton, on orange trees (Hedley). Type C3459 Australian Mus.

Pupisoma circumlitum Hedley, Rec. Australian Mus., iii, Aug. 5, 1897, p. 44, pl. 11, f. 1, 2, 3.

"This snail conceals itself by plastering the shell over with grains of earth, etc., entangled in mucus. The device reminded me of the European *Balea perversa,* which adopts the same habit in similar situations. Occasional abrasions seem to show that the color resides in a very thin epidermis" (*Hedley*).

In Bundaberg topotypes, received from Hedley, the microscope shows fine, close spiral lines on the base, weak traces of them also above the periphery. The oblique striation is of the same character as in *P. orcula,* but the umbilicus is per-

haps a trifle more open. It appears to be a form of *orcula*. Hedley's line figures are copied.

14. *Pupisoma vimontianum* (Crosse). Pl. 3, fig. 13.

Shell having an almost wholly covered umbilical crevice, oval-conic, marked with minute, oblique, very fine striæ, visible only under a lens, thin, but little shining, translucent, clear corneous. Spire convexly conic, the summit obtuse. Suture well marked. Whorls 4, convex, the last rounded, nearly as long as the spire. Aperture subvertical, rounded-semilunar, inside colored like the shell. Peristome simple, with converging margins; columellar margin short, straight, reflected, almost wholly covering the umbilical crevice, whitish; basal and outer margins rounded and sharp. Height a little less than 2, greatest diam. 1½ mm.; length and width of the aperture ¾ mm. (*Crosse*).

New Caledonia: neighborhood of Noumea (E. Marie).

Helix vimontiana Crosse, Journ. de Conchyl., xxii, 1874, p. 108; xxiii, 1875, p. 217, pl. 9, f. 2.

Not known to me by specimens. Compare *P. orcula*.

15. *Pupisoma steudneri* (Jickeli). Pl. 2, figs. 6*a-d*.

The imperforate conic-globose shell is of a somewhat greenish color, under the lens covered with close, oblique, cuticular longitudinal riblets. The conic spire has an obtuse apex. The 4 inflated whorls are separated by a deep suture. The last whorl forms two-fifths of the total length, descends very slightly in front, and is inconspicuously angular at its periphery. The oblique aperture is long-rounded, with a straight, thin peristome, reflected and dilated at the insertion of the columellar margin; on account of the very strong expansion of the columellar reflection an umbilical crevice may be spoken of. The terminations of the lip converge. On the base of the last whorl a very delicate spiral striation may be observed in some examples, under a very strong lens. Alt. 1.75, diam. 2 mm. (*Jickeli*).

Abyssinia: plateau of Rora-Beit-Andu, prov. Hamaszen, under rotting leaves on stones (Jickeli).

Helix membranacea Jickeli, Mal. Blätter, 1873, p. 102; not of Lowe.—*Helix steudneri* Jickeli, Nova Acta Acad. Caes.-Leop.-Carol. Germ. Nat. Cur., vol. 37, 1875, p. 60, pl. 4, f. 21.

This form does not appear to differ materially from *P. orcula*. As I have not seen specimens, and the locality is remote, it may be left on probation.

American Species.

I. Shell with minute spiral striæ. *P. dioscoricola,* no. 16.
No spiral striæ II
II. Surface with growth-lines only. *P. michoacanense,* no. 17.
Surface pitted-granulose III
III. About 4 to 4½ whorls. .....*P. mediamericanum,* no. 20.
About 3½ whorls. IV
IV. Diam. 1.35 mm., umbilicus narrow. ....*P. minus,* no. 18.
Diam. 1.5 mm., umbilicus wider.....*P. macneilli,* no. 19.

16. Pupisoma dioscoricola (C. B. Ad.). Pl. 4, figs. 1, 2, 3, 4, 5.

Shell very small, thin, subglobose, imperforate, of 3 very convex whorls; the last rounded, narrowly indented beneath; lip thin. Divergence 70°; alt. .05, greatest diam. .06, minor diam. .05 inch'' [about 1.25, 1.5, 1.25 mm.]. Jamaica (*C. B. Adams*).

The shell is globosely conic with obtuse apex, perforate, cinnamon-colored, glossy. Sculpture of unequal growth-wrinkles crossed by fine, impressed spiral lines about equally distinct over the whole last whorl; earlier whorls with granose striæ or somewhat irregular granulation, partly confluent into striæ. The tip of the apex is slightly depressed. The whorls are strongly convex. The aperture is truncate-rounded, oblique. Peristome thin, the columellar margin whitish, dilated triangularly and broadly over the perforation. Columella concave.

Length 1.55, diam. 1.55 mm.; 3½ whorls (fig. 1).

Length 1.95, diam. 1.8 mm.; 3⅔ whorls (Brownsville).

Southern Florida and southern Texas to southern Brazil; specimens seen by the author from the following localities:

Florida: Cayo Tuna, Lossman's Key and Cape Sable on the west coast. Cape Florida, Elliotts, Old Rhodes, Little Palo Alto, Angel Fish, Pumpkin, Largo, Long. Lignum Vitæ

and Big Pine Keys, on the east and south. Ft. Lauderdale, Lemon City, Miami, Snake Creek Hammock, 4 miles south of Lakeview, in the Dade Co. mainland (A. N. S. P. and G. H. Clapp collections). Gainesville (Clapp coll.).

Texas: Brownsville (R. D. Camp).

Jamaica: Stony Hill, St. Andrews; Orange Hill, Montego Bay; near Mandeville, Manchester (A. P. Brown). Haiti: San Lorenzo, south side Samana Bay, Santo Domingo (Dr. W. L. Abbott). Vieque (T. Bland). Costa Rica (Wm. M. Gabb). Canal Zone: Juan Vinas (Jas. Zetek). Trinidad (Guppy). Brazil: City of Sao Paulo (H. von Ihering).

Additional localities on record: Merida, Yucatan (Morelet for *H. punctum*); Cuenca, Ecuador (Milldff. for *P. americanum*).

Helix dioscoricola C. B. Ad., Proc. Boston Soc. N. H., ii, 1845, p. 16.—Pfeiffer, Monogr. Hel. Viv., i, 42; Conchylien Cabinet, *Helix*, p. 240, pl. 30, f. 29-31 (restoration from a broken shell).—*Helix* ——, Costa Rica, Binney, Ann. N. Y. Acad. Sci., iii, p. 113, pl. 5, f. L (teeth).—*Thysanophora dioscoricola* (C. B. Ad.), Pilsbry, Man. of Conch., ix, p. 57.

H.[*elix*] *punctum* Morelet, Testacea Novissima Ins. Cubanæ et Americæ Centralis, ii, 1851, p. 9.—Crosse & Fischer, Miss. Sci. Mex., Moll., i, p. 228, pl. 12, f. 1*a-b*.—Von Martens, Biol. Centr. Amer., Moll., p. 131, pl. 7, f. 3–3*b*.

Helix caeca Guppy, Proc. Sci. Asso. Trinidad (Dec., 1868), 1869, p. 241; Amer. Journ. Conch., vi, p. 307. — Pfeiffer, Monogr. Hel. Viv., vii, p. 527; Conchylien Cabinet, *Helix*, p. 539, pl. 163, f. 26-28.—Dall, Nautilus, iii, 1889, p. 25, pl. 1, f. 9 (St. Augustine, Lake Worth, Hillsborough River).—*Thysanophora cæca* (Guppy) Pilsbry, Man. of Conch., ix, p. 57. —Suter, Revista Museu Paulista, iv, 1900, p. 335, pl. 3, f. 1 (shell), 2 (jaw), 3 (teeth); (City of Sao Paulo). — Clapp, Nautilus, xxxi, p. 74, pl. 8, f. 3.—*Thysanophora dioscoricola cæca* (Gpy.), Rhoads, Nautilus, xiii, 45 (Miami, Fla.).

The greater distinctness of the spiral lines over the whole last whorl and the coarser granulation of the early whorls will usually serve to differentiate the typical form of *dioscoricola* from Oriental *orcula*. As in *orcula*, the spire be-

comes higher relative to the diameter with age. C. B. Adams' measurement of the altitude was probably of the axis, not to the base of the lip.

This minute snail certainly inhabits a vast area, entirely similar specimens occurring from about 30° north latitude to about 24° south.

It may be inferred that C. B. Adams found this species on leaves of the yam (*Dioscorea*). S. N. Rhoads reported it as "numerous in certain localities [about Miami, Fla.] on the under surface of the leaves of magnolia and of palmetto; on the latter sometimes a score can be taken from a single leaf." Morelet found *Helix punctum*, which seems to equal *dioscoricola*, on leaves of trees.

The species is probably found all over Jamaica, as the localities given above are on the south and north shores and the high interior. Several unlocalized Jamaican lots from the older collectors are also in our collection. In one of the shells from Montego Bay there are strong wrinkles at rather wide, unequal intervals; otherwise the Jamaican specimens are much alike. Most specimens from Florida agree with those of Jamaica; in some the spiral lines are somewhat weaker.

Specimens from the Canal Zone and from Vieque are rather small, the striæ and spiral lines fine and delicate though distinct. Probably they are not absolutely mature.

The following appear to be synonyms.

Helix cæca Guppy, described from Trinidad, is, according to a series received from that author many years ago, practically typical *dioscoricola*. The spiral lines are weak, barely discernible on the upper part of the last whorl in some specimens, but in others distinctly developed throughout, though not strong. One of this lot is figured, pl. 4, fig. 5. Pfeiffer's figure, doubtless from a specimen from Guppy, was copied by Tryon in MANUAL, vol. II, pl. 53, figs. 46, 47. Guppy described it as costulate, Pfeiffer as striatulate; the latter term is more appropriate. Two examples measure: Length 1.6, diam. 1.6 and 1.65 mm.

Helix punctum Morelet is in no way differentiated from

dioscoricola by the characters and figures which have appeared. A figure was copied by Tryon from Crosse & Fischer in MANUAL, vol. III, pl. 9, fig. 7. Von Martens' figures are reproduced in our pl. 4, figs. 13, 14. All of these were drawn from specimens from Morelet. The original description follows.

"*H. punctum.* Shell covered-perforate, small, globose, turbinate, corneous-rufous; whorls 3½, convex; aperture lunar; peristome simple, acute, the columellar margin a little reflected, vaulting over the umbilicus. Diam. 1⅔ mm. On leaves of trees in gardens of the city of Merida" (*Morelet*).

Neither Crosse and Fischer nor von Martens give any account of the sculpture, though these authors figure specimens from Morelet. Presumably the shell appeared smooth under a hand lens, a higher power being required to bring out the spiral striation in most of this group.

Pupisoma americanum Mlldff. appears from the description, translated below, to be identical with *dioscoricola*. Von Moellendorff supposed that no similar form had been reported from America, and therefore did not compare *dioscoricola, punctum* and *cæca*.

"*Pupisoma americanum.* Shell narrowly and half-covered perforate, conoid-globose, thin, subpellucid, distinctly striatulate, buff-corneous. Spire convexly conoid, obtuse at apex. Whorls scarcely 4, convex. Aperture strongly oblique, subcircular, moderately excised; peristome unexpanded, the columellar margin dilated above, reflected. Alt. 1.75, diam. 1.75 mm. Cuenca, Ecuador." Strubell collection. (*Moellendorff,* Nachrbl. d. Mal. Ges., vol. 31, June 1899, p. 91.)

Spiral striation is not mentioned, yet as it would not be seen with a hand lens, it is probably present. Moellendorff did not mention it in describing his *P. philippinicum*. He evidently did not use a microscope.

P. dioscoricola insigne n. subsp. Pl. 4, figs. 6, 7, 8.

Sculpture rougher by the presence of coarse wrinkles or low riblets at unequal intervals among the finer growth-ripples; whorls 3⅔ to nearly 4. Other characters as in typical *dioscoricola*.

Length 1.95, diam. 1.85 mm.; nearly 4 whorls.

Texas: Brownsville, type loc. (fig. 7). Hidalgo (fig. 6). Mexico: Valles Falls, Ganina River and Choy cave, San Luis Potosi (A. A. Hinkley); Izamal, Yucatan (Heilprin Exped.). Demerara (fig. 8), (R. Swift).

The single example from Demerara has the ribs very strongly developed (pl. 4, fig. 8). Those from San Luis Potosi have very distinct spiral lines, 4 whorls.

A few similarly sculptured specimens were found in lots from Miami and Gainesville, Florida, and, as mentioned above, one was found at Montego Bay, Jamaica; in both cases among typical *dioscoricola*, and having the same number of whorls. The status of the form is therefore somewhat doubtful, but it would be a fault to omit notice of a form so conspicuously differentiated.

17. PUPISOMA MICHOACANENSE n. sp. Pl. 4, fig. 12.

The shell is narrowly perforate, globosely conic, higher than wide, grayish buff (corneous). Surface marked with some irregularly-spaced growth-wrinkles but without spiral lines. The aperture is rounded, not much excised by the penult whorl, peristome simple, the columellar margin triangularly dilated but less broadly than in *P. dioscoricola*. Length 1.6, diam. 1.4 mm.; 3½ whorls.

Mexico: Morelia, Michoacan, S. N. Rhoads, 1899. Type 77119 A. N. S. P.

Distinguished by the high contour and absence of spiral sculpture.

18. PUPISOMA MINUS n. sp. Pl. 4, figs. 9, 11.

The shell is very narrowly umbilicate, globose-conic, cinnamon-colored, but slightly glossy. Sculpture of very minute, shallow, confluent pits, or it might be described as densely vermiculate-granose; a few striæ are indistinctly developed, but no trace of spiral lines. The whorls are strongly convex. Aperture rounded-oval, excised moderately by the penult whorl. Peristome simple and thin, the columellar margin broadly dilated, half covering the umbilicus.

Length 1.35, diam. 1.23, length of aperture 0.7 mm.; 3½ whorls.

Florida: Crystal River, Citrus Co. (C. B. Moore); Tick Island, Volusia Co. (Pilsbry & Johnson, 1894); Dade Co. at Lemon City (S. N. Rhoads), and Snapper Creek, south of Cocoanut Grove, type loc. (Morgan Hebard). Elliott's Key, Pumpkin Key, Ft. Lauderdale, near Coot Bay, Cape Sable. Jamaica: Mandeville, Manchester (A. P. Brown); west of Port Antonio (Henderson). Guatemala: Chamá (A. A. Hinkley).

Thysanophora dioscoricola (C. B. Ad.), Clapp, Nautilus, xxxi, Jan. 1918, p. 75, pl. 8, f. 2.

All of the specimens from Florida were found in leaf and earth siftings, only one or a few from each of the localities mentioned. It is readily differentiated from *P. dioscoricola* by the minute size, larger umbilicus, less rapidly expanding whorls, and especially by the sculpture. Half-grown *Bothriopupa variolosa* has similar sculpture, but the first whorl is much smaller and the last less ample, besides differing in form.

The single example from Crystal River (in western Florida about 25 miles below Cedar Keys) has a low prominence on the columella, in an oblique view (pl. 4, fig. 10). Further specimens from this part of the state should be examined, as no such structure appears in any other specimens seen.

The two specimens from Guatemala and four from Jamaica do not seem to differ from those of Florida.

This species stands close to *P. macneilli* Clapp, but appears to differ constantly by the narrower umbilicus and the more oblique aperture. It has not the riblets at irregular intervals of *P. mediamericanum* and does not attain to the size of that species.

P. minus was first recognized as a distinct species by Dr. G. H. Clapp, who figured it as *dioscoricola*.

19. Pupisoma macneilli (Clapp). Pl. 4, fig. 15.

Shell small, globose, with about four well-rounded whorls; suture deep; color chestnut-brown, somewhat shining; sur-

face with faint growth-lines and microscopically granulated; apex obtuse, large, more densely granulated than the body of the shell; widely umbilicate, with the umbilicus extending to the apex and contained about 5 times in the diameter of the shell. Aperture well rounded, slightly oblique; lip thin, partly reflected around the umbilicus. The type measures, alt. 1.5, diam. 1.38, umbilicus 0.29 mm. (*Clapp*).

Length 1.3, diam. 1.25 mm.; 3½ whorls (cotype).

Alabama: Magazine Point, 8 miles north of Mobile. Also found at Spring Hill and along the Fowl River, about 3 miles from the coast in the southern part of Mobile Co. (L. H. McNeill).

Thysanophora macneilli Clapp, Nautilus, xxxi, Jan. 1918, p. 74, pl. 8, f. 1.

In the cotype figured the umbilicus is contained 5⅔ times in the diameter. Dr. Clapp's figure shows 3½ whorls, and this is the number counted in the cotype figured. The umbilicus is larger than in *P. minus* and the aperture is less oblique, this being particularly noticeable in a basal or a profile view.

20. Pupisoma mediamericanum n. sp. Pl. 4, figs. 16, 17.

The shell is perforate, globose-conic, thin, olive-buff, somewhat glossy. Sculpture of widely, unevenly spaced low riblets, the intervals somewhat roughened by shallow pitting, without spiral striation, the first two whorls very minutely granulose. The whorls are strongly convex. Aperture truncate-rounded. Peristome thin, slightly expanded below, the columellar margin rather broadly dilated over the rather large perforation.

Length 1.7, diam. 1.44, length aperture 0.7 mm.; 4½ whorls.

Length 1.7, diam. 1.46, length aperture 0.7 mm.; 4½ whorls.

Length 1.65, diam. 1.3 mm.; 4 whorls. Chamá.

Length 1.6, diam. 1.3 mm.; 4 whorls. Chamá.

Mexico: about 500 ft. above the town of Orizaba (Heilprin Expedition, 1890). Type and paratypes 28270 A. N. S. P. Chamá, Guatemala (A. A. Hinkley).

The high form, distinct riblets and greater number of

whorls separate this species from *P. dioscoricola;* in the last two characters it differs from *P. michoacanensis,* which also differs by lacking the confluent pitting of the surface. It is much like *P. minus* in sculpture, except for the low, wide-spaced riblets of *mediamericanum;* also, the shell is more conic, with a smaller umbilical perforation and more whorls. *Bothriopupa breviconus* Pils. has a somewhat similarly pitted surface, but it is toothed, a little smaller, with the whorls increasing less rapidly, the aperture therefore smaller.

Genus CYLINDROVERTILLA Boettger.

Cylindrovertilla Bttg., in v. Martens' Conchologische Mittheilungen, i, 1881, p. 62, for *Pupa paitensis* and *P. fabreana.* —Pilsbry, Proc. A. N. S. Phila., 1900, pp. 427, 428.

The shell is sinistral, minute (length 1.6 to 2 mm.), ovate or oblong, tapering towards both ends, smoothish; aperture with long angular and short columellar lamellæ, 1 or 2 palatal folds; peristome expanded, thickened within, the terminations remote.

Type *C. fabreana* (Crosse).

Distribution: New Caledonia, coasts of Queensland and New South Wales, Australia.

The chief peculiarity of this genus is that there is *no parietal lamella,* but a strongly developed *angular lamella* emerging to or towards the termination of the outer lip. This is a highly peculiar condition; yet from the relation of the lamella to the lip, exactly as in *Ptychalæa* and *Nesopupa,* there can be no doubt as to its homology with the angular lamella of other genera.

Another peculiarity of *Cylindrovertilla* is that the upper palatal fold is stronger than the lower, and persists when the latter is lost. In most Pupillidæ the lower palatal fold is the stronger and more constant.

The columellar axis is very small, and the columellar lamella extremely short. There is no basal fold in known species, unless it is represented by the basal thickening of the lip-callus in *C. fabreana.*

Key to species of Cylindrovertilla.

a^1. Aperture having two palatal folds.

b^1. Weakly striate; 1.95 mm. long, of 5 whorls; Australia. *C. kingi*, no. 1.

b^2. Nearly smooth; 1.75 mm. long, of 4½ whorls; New Caledonia. *C. paitensis*, no. 4.

a^2. Aperture having one palatal fold, the upper palatal.

b^1. Distinctly though minutely striate; lip-callus not thicker at the base than elsewhere; Australia. *C. hedleyi*, no. 2.

b^2. Striation very weak; lip-callus having a basal thickening or low nodule; New Caledonia, Queensland. *C. fabreana*, no. 3.

1. CYLINDROVERTILLA KINGI (Cox). Pl. 5, figs. 1, 2, 3.

The shell is sinistral, rimate, ovate, between cinnamon and fawn color. Surface glossy, very closely, minutely striate, the striæ oblique, very low, usually most distinct on the penult whorl, partly effaced or in part replaced by irregular granulation on the last. The apex is obtuse. Whorls are rather strongly convex, the last having a wide or strong, *rounded, striate crest* behind the outer and basal lips, of a dull orange-cinnamon color; behind the crest it is somewhat flattened laterally, convex below the suture. The aperture is somewhat oblique, shortly piriform, the peristome expanded, heavily thickened within by an orange-cinnamon or paler callous ridge. The angular lamella is strong, white, its emerging outer end low, curving to join (or nearly join) the termination of the outer lip. Columellar lamella white, rather small and short, almost tuberculiform. The upper palatal fold is short, not emerging to the callous rib. Lower palatal fold smaller and a little deeper within.

Length 1.95, diam. 1.1 mm.; 5 whorls.

Australia, New South Wales: Paramatta (R. L. King, type loc.), Vancluse Point, Port Jackson (C. Hedley); Glebe Point, Sydney (Brazier), Wollongong (Masters, *P. mastersi* Cox). Queensland: Burleigh Head Island.

Pupa kingi Cox, Ann. Mag. N. H. (3), xiv, Sept. 1864, p.

183; Catalogue of the specimens of the Australian Land Shells in the collection of James C. Cox, etc., 1864, p. 28; Mon. Australian Land Shells, 1868, p. 79, pl. 14, f. 17, 17*a*.—*Vertigo kingi* Cox, var., HEDLEY, Proc. Roy. Soc. Queensland, v, 1889, p. 102 (Burleigh Head).—*Pupa mastersi* Cox, Catalogue, p. 29.—*Cylindrovertilla kingi* (Cox), PILSBRY, Proc. A. N. S. Phila., 1900, p. 426, fig. 3.

Cox described *Pupa kingi* as having three teeth. The types were stated to be in "Mus. Rev. R. L. King," and are now (two specimens) in the Australian Museum. They were collected at Paramatta, 13 miles from Sydney. Specimens collected by Mr. Hedley at Vaucluse Point, drawn in figs. 1, 2, 3, were compared with the types and pronounced by Mr. Hedley the same. All of them have four teeth; also no. 22921 of the collection, from Sydney (W. P. Wilstack, 1867), figured in Proc. A. N. S. Phila., 1900, p. 426. In the absence of 3-toothed specimens from the Sydney district it may be assumed that Cox overlooked the small lower palatal fold. However, he described *Pupa mastersi* (from Wollongong, further south) as having four teeth; subsequently (1868) he decided that it was a synonym of *kingi*. The specimens here described and figured agree with the description of *P. mastersi*.

Specimens from Burleigh Head Island, near the southern boundary of Queensland, agree with those of the Port Jackson district, all having four teeth, the palatals small.

The original descriptions follow:

Pupa kingsi. — P. testa sinistrorsa, profunde et breviter rimata, ovato-oblonga, tenui, laevigata, nitida, hyalina, rubido-castanea; spira convexa, apice obtusa; anfractibus 4, convexiusculis, ultimo semilongitudinem testae vix aequante; apertura verticali, irregulariter constricta et subbipartita; tridentata, dente conspicuo acutiusculo in pariete aperturali, altero minore latiore et obtuso in columella, tertio minimoque in margine externo; peristomate incrassato et breviter expanso, ore rubido, dentibus albis. Long. 0.05, diam. 0.03 unc.

Hab.: Parramatta (King). Mus. Rev. R. L. King.

In 1868 Cox gave the length as 0.07 inch, much nearer the true size.

Pupa mastersi. — P. testa sinistrorsa, perforata, ovato-oblonga, nitidiuscula, rufo-cornea, translucente; spira convexo-turrita, obtusissima; anfractibus 5, ultimo ceteros subaequante; apertura verticali, magna, truncato-rotunda, quadridentata, dente primo prominente compresso plicae simili in medio parietis aperturalis, secundo valido obtuso conico in margine interiore juxta angulum, tertio angusto in labio externo, quarto profunde in fauce; axi centrali; peristomate externe paulo sinuato, modice incrassato et breviter expanso. Long. 0.03, diam. 0.08 unc.

Habitat: Wollongong (Masters).

There is an evident error in the measurements, the length and diameter were transposed.

2. CYLINDROVERTILLA HEDLEYI n. sp. Pl. 5, figs. 4, 10.

The shell resembles *P. kingi* as above defined except in the following particulars: The surface is much more distinctly striate, and on the last whorl there is more of the minute malleation or confused granulation noted for *kingi*. The crest behind the lip is more oblique, the broad pit preceding it deeper. The upper palatal fold is longer, more immersed, and there is no trace of a lower palatal fold. There is a rather strong callous rib within the lip. The angular lamella is thin and but slightly sigmoid in basal view.

Length 1.8, diam. 1.07 mm.; 4½ whorls.

Australia: Calliungal, in southern Queensland (C. T. Musson).

P. kingi Cox, in part, HEDLEY and MUSSON, Proc. Linn. Soc. N. S. W. (2), vi, 1891, p. 558.

This species is larger and more coarsely striate than *C. fabreana;* the angular lamella penetrates less deeply, and it does not have the basal thickening of the lip-rib characteristic of that species.

The color is lighter, more buff than *C. kingi*, without reddish or orange tint around the mouth; but the specimens are all "dead" though fresh. They are part of the lot catalogued by Hedley and Musson, received from Charles Hedley.

3. CYLINDROVERTILLA FABREANA (Crosse). Pl. 5, figs. 5, 7-9, 12, 13.

Shell umbilicate, sinistral, subovate-oblong, thin, translucid, scarcely shining, corneous. Spire moderately elevated, the apex obtuse. Suture lightly impressed. Whorls 5, convex, regularly increasing, the last shorter than the spire ($\frac{1}{2} : 1\frac{1}{2}$), strongly scrobiculate or pitted outside where the outer passes into the basal margin. Aperture subvertical, semioval, contracted by three folds colored like the shell: first a strong parietal, second marginal [palatal], deeply placed, third columellar. Peristome narrowly expanded, a little thickened, corneous-whitish, the basal margin thickened within at the place of the external pit, the outer margin somewhat inflexed in the middle.

Length 1.5, diam. $\frac{2}{3}$ mm. (Crosse).

New Caledonia: Vata, near Noumea (E. Marie). Australia: Boyne Island, Queensland (Musson).

Pupa fabreana CROSSE, Journ. de Conch., xx, 1872, p. 359; xxii, 1874, p. 392, pl. 12, f. 6.—PFR., Monogr., viii, 391.—BOETTGER, Conchol. Mittheil., i, p. 63.—*Vertigo fabreana* CROSSE, Journ. de Conch., xlii, 1894, p. 304 (1896).

A species very close to *Pupa paitensis*, which is also sinistral, but to be distinguished as follows: the shell is umbilicate, not perforate-rimate, oblong rather than ventricose, a little more glossy, the spire less conic, whorls 5 instead of $4\frac{1}{2}$, the last smaller than the spire and externally having two pits, the aperture with three teeth instead of one (*Crosse*).

The larger angular and upper-palatal folds and especially the thickening of the callus within the basal lip characterize this species, of which topotypes (figs. 7, 8, 9) from Marie and G. Dupuy have been examined. The original figure of Crosse is copied in fig. 5.

The shell is chamois-colored, weakly, faintly striate, with traces of fine malleation on the last whorl. Behind the lip there is a rather deep, wide impression or pit over the upper palatal fold, the whorl swollen above and below it, and on the base there is another impression close behind the lip. The aperture is small, oblique. The expanded peristome has a

heavy internal callus, narrow in the sinulus, an obtuse inward projection below it; and in the base the callus rises in a low, wide boss. The angular lamella is very long and somewhat sinuous. Columellar lamella rounded. Upper palatal fold rather long, higher and bent down within, weakly emerging to the lip-callus. There is no lower palatal fold.

Length 1.75, diam. 0.85 mm.; 4½ whorls. Anse Vata.

Length 1.63 mm.

Length 1.8 mm.

A series of this species was collected on Boyne Island, southeastern Queensland, by C. T. Musson. The specimens, or some of them, show a trifle more striation than those of New Caledonia, and the angular lamella may be slightly more sinuous; but the differences noted are trivial. An average example and one somewhat stouter and more distinctly striate are figured. They measure:

Length 1.65, diam. 0.84 mm. Fig. 12.

Length 1.63, diam. 0.9 mm. Fig. 13.

4. CYLINDROVERTILLA PAITENSIS (Crosse). Pl. 5, fig. 6.

The shell has a well-marked umbilical crevice, is sinistral, of oval-oblong shape, a little ventricose, thin, corneous. Spire moderately conic, terminating in an obtuse summit. Suture lightly marked. Whorls 4½, convex, a little inflated, increasing regularly, the last whorl nearly as large as the spire and tapering to the base. Aperture subvertical, semi-oval, contracted by the presence of a single quite strong parietal fold. Peristome thick and of a brownish-corneous violaceous color. Outer margin slightly bent in. Length 1.5, greatest diam. 0.75 mm. (*Crosse*).

New Caledonia: Paita, on the west coast (E. Marie).

Pupa paitensis CROSSE, Journ. de Conch., xx, 1872, p. 227; xxii, 1874, p. 391, pl. 12, f. 5.—BOETTGER, Conchol. Mittheil., i, p. 63.—*Vertigo paitensis* CROSSE, J. de C., xlii, 1894, p. 304 (1896).

This species evidently stands very close to *C. kingi* of Australia. It appears to differ in certain details, but I have not been able to compare specimens, and have copied the original figure.

According to Boettger, who described a specimen received by Pfeiffer from Crosse, the two small, deeply placed palatal folds were overlooked by Crosse. Boettger gives the following description:

The shell is sinistral, narrowly perforate-rimate, oblong-ovate, subventricose, thin, rather glossy, corneous-yellow. Spire convexly conic, the apex rather acute. Whorls 4½, a little convex, regularly increasing, parted by an impressed suture, nearly smooth, the last about ⅔ of the total length, somewhat tapering at base, at the aperture lightly 2-pitted and encircled with a distinct annular callus [crest] colored like the shell. Aperture subvertical, somewhat heart-shaped, 4-toothed. Parietal compressed, rather deeply placed, lamelliform; columella straight and narrow, truncate and *quasi*-uniplicate at base; palatals 2, parallel, not very strong, remote, the lower very deeply placed. Peristome with a long interruption, somewhat thickened, the outer margin somewhat inflexed and slightly produced angularly. Length 1.75, diam. 1 mm.

Genus STERKIA Pilsbry.

Sterkia Pils., Nautilus, XI, Feb. 1898, p. 119.

The shell is minute (1½ to 2 mm. long, of 4½ to 5½ whorls in known species), perforate, *cylindric* with very short apical cone and *obtuse summit;* thin, brown, slightly wrinkled or rib-striate. Aperture about as wide as long, the peristome expanded or reflected, brown, thin, terminations remote; angular and parietal lamellæ long, not connected, the angular running to the posterior termination of lip; columellar lamella and 2 palatal plicæ present.

Type, *S. calamitosa* (Pils.).

Distribution, Southern and Lower California, and from southern Florida to Guatemala and Guyana.

These minute, blunt-topped Pupillids have much the external appearance of the Old World genus *Truncatellina*, but they differ in apertural armature. The teeth show relationship with *Ptychalæa* and *Nesopupa*, genera now mainly living on the Pacific Islands and Oriental Region, but in the middle Tertiary also in Europe, associated with *Gastrocopta* and other Holarctic genera. Though paleontologic evidence is

lacking, it may perhaps be inferred that the modern Sterkiæ are diminutive descendants of an early Tertiary *Ptychalæa*-like stock of Holarctic distribution.

The typical species of the genus are remarkably specialized in teeth. The section *Metasterkia* contains more primitive species.

The living animal has not been observed. It will probably be found to lack inferior tentacles, if our estimate of its affinities is correct.

The Eastern or Antillean herd is widely remote from that of Lower California, yet we know so little of the minute shells of tropical America that part of this separation may be due to the deficiencies of our Mexican collections. The genus will probably be found widely spread in the West Indies and shores of the Caribbean Sea.

Key to species of Sterkia.

a^1. Shell distinctly rib-striate; lamellæ and plicæ large; the inner end of the columellar lamella bent vertically downward (Section *Sterkia*, proper).

b^1. Columellar lamella forming a large, vertical plate, visible in the aperture; both palatal folds visible in a front view. Lower California. *S. calamitosa*, no. 1.

b^2. Vertical part of the columellar lamella not conspicuous; lower palatal fold not visible in a front view; upper palatal fold very long; base humped. Southern and Lower California. *S. hemphilli*, no. 2.

a^2. Shell nearly smooth; palatal folds not very large, all visible in a front view; columellar lamella turned upward within or horizontal (Section *Metasterkia*, type *S. antillensis*).

b^1. Columellar lamella median, short, entering horizontally; five or more whorls. California. *S. clementina*, no. 3.

b^2. Columellar lamella situated high, ascending within; Florida to Guyana.

c^1. Palatal folds small and short.

d^1. Diameter decidedly more than half the length. Guyana to Guatemala. *S. eyriesi*, no. 4.

d^2. Diam. about half the length. Southern Florida. *S. rhoadsi*, no. 5.

c^2. Palatal folds well developed, the lower one rather long. West Indies. *S. antillensis*, no. 6.

1. STERKIA EYRIESII (Drouet). Pl. 6, figs. 1, 2, 4, 5.

Shell very minute, perforate, cylindric-obtuse, short, smooth, glossy, thin, translucent, pale corneous. Whorls 5, convex, the suture deep, last whorl grooved. Apex very obtuse, rather depressed. Aperture somewhat triangular, 5-toothed; peristome subcontinuous, spreading, reflected. Length 1½, diam. 1 mm. (*Drouet*).

French Guyana: Ilet-la-Mère, on the trunk of *Spondias moubin*, quite abundant (Lieut. Charles Eyries). Cayenne (A. N. S. P.). Nickerie, Surinam (Voltz). San Fernando, Trinidad, on ferns (Guppy). Chamá, Guatemala (A. A. Hinkley).

Pupa eyriesii DRONET, Essai sur les Moll. terr. et fluviatiles de la Guyane Française, 1859, p. 71, pl. 2, f. 16*a*, 17.—BLAND, Amer. Journ. of Conch., iv, p. 186.—VERNHOUT, The Non-Marine Mollusks of Surinam, p. 20, in Notes Leyden Mus., vol. 36.—GUPPY, Journ. of Conch., vii, 1893, p. 220.

Drouet adds that the whorls are very convex, separated by a deep suture, the summit very obtuse, as though depressed, generally worn and grayish. Of the five teeth two are superior, one on the columella, one inferior and one on the right margin, which is sinuous.

Drouet's figures are copied, figs. 4, 5. The specimens from Cayenne (figs. 1, 2) are stouter with larger aperture than the original figures, but a certain latitude must be allowed in old figures of such minute shells; strict accuracy was rarely realized, and cannot be expected. Moreover, Drouet's measurements indicate a shell practically of the size of that drawn in our fig. 1. The color is between cinnamon and cinnamon-buff, the surface somewhat glossy, and distinctly though

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weakly striate, the initial whorl paler, microscopically granular. Whorls convex, especially the penult. The angular lamella curves to join the outer lip weakly. The parietal lamella is long and high. Columellar lamella is situated high on the columella, is short and ascends inward diagonally. The two palatal folds are short and high, the lower more immersed than the upper.

Length 1.7, diam. 1, alt. aperture 0.6 mm.; 4½ whorls.

Length 1.6, diam. 0.95, alt. aperture 0.56 mm.; 4½ whorls.

Some doubt must be expressed regarding Dr. Vernhout's identification of a specimen from Surinam, collected by Voltz, for he states that it is 2 mm. long.

A single example from Chamá, Guatemala, has the parietal lamella somewhat longer, entering more deeply, but agrees otherwise with those from Cayenne.

The two species following are closely related to *S. eyriesi*.

2. STERKIA RHOADSI (Pilsbry). Pl. 6, figs. 3, 6, 7.

The shell is rimate, very minute, cylindric, blunt at the ends, especially above, glossy, clay color, having weak, widely and unevenly spaced wrinkles. Whorls 4¾, the first 1½ smooth, the upper ones very convex, the last a little less so, somewhat compressed over the palatal region, and having a slight impression over the upper palatal fold. The aperture is about as wide as long, broadly truncate above. The angular lamella is curved, the concavity towards the periphery. It reaches inward hardly to the middle of the parietal lamella, which is longer and higher. The columellar lamella is situated high and ascends obliquely inward. There is a hardly noticeable callus below its inner end. The palatal plicæ are small, the lower one longer than the upper and a little more deeply placed. The peristome is brown, expanded and reflected, narrow in the upper curve of the outer lip, the margins remote, connected by a thin parietal callus.

Length 1.85, diam. 0.95, alt. aperture 0.65 mm.; 4¾ whorls.

Southern Florida: Miami (S. N. Rhoads); Dismal Key, Lee Co. (C. B. Moore); hammock 1½ miles northeast of Fort Lauderdale (C. T. Simpson in G. H. Clapp coll.).

Bifidaria rhoadsi PILS., Proc. A. N. S. Phila., 1899, p. 404, figs. 1, 2.

The teeth are slightly larger in the specimen from Dismal Key, of which an internal view is given (fig. 3). At present it is one of the rarest American snails. Only two specimens have been found in the great amount of woodland debris which has been worked over in this laboratory. Dr. Clapp found about a dozen in a bushel of rubbish from near Fort Lauderdale, a place on the mainland above Miami.

Very close to *S. eyriesi*. The shell is a little larger and more slender, with relatively smaller aperture. No actual intergradation in these characters has been observed in the very small number seen; yet it seems unlikely that they will prove of specific constancy when fuller series come to hand.

It resembles *B. clementina* in the relatively smooth surface and moderately developed teeth, but differs by the obliquely ascending columellar lamella and other details of structure.

3. STERKIA ANTILLENSIS n. sp. Pl. 6, figs. 8, 9, 10, 11.

The shell is shortly cylindric, cinnamon-colored, glossy, under the microscope showing some weak, uneven striation and rugosity (such as the typical Nesopupæ have, but only weakly developed), the first 1½ whorls microscopically granular. The summit is obtuse; whorls strongly convex, the last having a furrow behind the lip, over the upper palatal fold. The aperture has a rather distinct sinulus, the outer lip being bent in. The peristome is well developed and colored like the exterior. The angular lamella is high, curved, and more or less strongly connected with the termination of the lip. Parietal lamella high and long. Columellar lamella situated high, obliquely ascending inwardly. The two palatal folds are well developed, both somewhat immersed, but the lower one more deeply.

Length 1.73, diam. 0.95, alt. aperture 0.7 mm.; 4⅔ whorls.

Length 1.85, diam. 1 mm.; 4¾ whorls.

Cuba: El Abra, Viñales (type loc.) and Rosario (Henderson). Jamaica: west of Port Antonio (Henderson and Simpson); near Mandeville (Dr. A. P. Brown).

This species is distinct from *S. eyriesi* and *S. rhoadsi* by the more strongly developed teeth, particularly the longer, stouter palatal folds.

In a specimen from Mandeville there is a well developed interpalatal fold near the inner end of the upper palatal. The lower palatal is unusually long and the size small: length 1.53 mm. (figs. 10, 11). Whether these are individual or racial peculiarities cannot be determined without more material. This specimen was reported as *Bifidaria rhoadsi* in Proc. A. N. S. Phila., 1910, p. 521.

4. STERKIA CLEMENTINA (Sterki). Pl. 7, figs. 9, 10, 13.

"Shell very minute, narrowly perforate, cylindrical, pale horn-colored, transparent, with rather obtuse apex; whorls 5½, regularly increasing, moderately rounded, with rather deep suture, smooth, with few microscopic striæ, somewhat shining; last whorl occupying rather more than two-fifths of altitude, somewhat ascending to the aperture, with a slight, revolving impression on the middle of its last third, ending at the auricle; a very slight, flat, crest-elevation near the margin, only in the lower part. Aperture lateral, scarcely oblique, subovate with the palatal margin slightly flattened, upper part of same somewhat sinuous, peristome a little expanded with a slightly thickened lip just at the margin; lamellæ 6, white: two on the apertural [parietal] wall, the apertural [parietal lamella] typical, and a rather long supra-apertural [angular] ending in a callus at the upper termination of the palatal margin; columellar one typical, horizontal; basal very small, nodule-like, deep seated; palatals two, typical, the inferior a little longer.

"Alt. 1.9, diam. 0.8 mm.; apert.: alt. 0.6, diam. 0.5 mm. (*Sterki*).

"Alt. 1.8, diam. 0.9 mm.; 5 whorls. Paratype."

San Clemente Island, California, type loc.; also Santa Barbara Island (H. Hemphill).

Pupa clementina STERKI, Nautilus, iv, August, 1890, p. 44, pl. 1, f. 4. — *Bifidaria clementina oldroydæ* VANATTA, Nautilus, xxx, August 1916, p. 48.

Only three specimens were found by Mr. Hemphill on San Clemente, one of which, no. 45479 A. N. S. P., is here figured.

The surface shows very weak traces of low, widely-spaced striæ, usually hardly noticeable; color between cinnamon and cinnamon-buff, or paler. There is a distinct but shallow impression over the upper palatal fold, running to the lip. The angular lamella is longer and much lower than the parietal, its summit depressed in the middle part; it is nearly straight, but curves outward a little to join the outer lip, with a rather thick callous pad at the junction. The parietal lamella is nearly straight. The columellar lamella is short, transverse to the axis, its inner end thick. The upper palatal fold is short, the lower higher, thicker and longer. A basal fold, mentioned in Sterki's description, is not present in the cotype here figured. It was also absent in Sterki's figure, drawn by himself.

Bifidaria clementina oldroydæ Vanatta, from Santa Barbara I., stated to differ from *clementina* by the absence of a basal fold, appears to have no sufficient basis, since this fold is also wanting in some, if not all, San Clemente shells of the type lot. The type of *oldroydæ* (figs. 10, 13) measures: length 1.9, diam. 0.85 mm.; 5¼ whorls.

S. clementina differs from other West Coast species of the genus by its relatively small, simple teeth. It is related to the Antillean species and *S. rhoadsi*, but the columellar lamella is not situated so high and differs somewhat in shape, the palatal folds are nearer together, and there are more whorls.

5. Sterkia hemphilli (Sterki). Pl. 7, figs. 5-8, 11, 12.

The shell is narrowly umbilicate and rimate, cylindric, brown, resembling *S. calamitosa;* strongly rib-striate after the 1½ smooth initial whorls, the ribs and intervals about equal on the earlier, slightly more spaced on the last whorl. Whorls 4½, strongly convex, the last slightly less convex, impressed over the upper palatal fold, peculiarly swollen or obtusely humped in the middle of the base, the umbilical margin impressed beyond the hump, this impression forming a boss in-

side (figs. 11, 12). Aperture about as wide as long, the outer lip biarcuate, the upper arc shorter and more convex, with a narrower lip than the lower. Angular lamella joining the outer lip, thin, high and nearly straight. Parietal lamella shorter, crescentic, the concavity towards the columella, high and bent outward in the middle, tapering towards both ends, reaching forward to a point opposite the middle of the angular lamella. Columellar lamella consisting of a rather low, horizontal portion curving into a shorter vertical portion descending on the axis, and a less conspicuous but longer branch ascending the axis (figs. 5, 12). The upper palatal fold is rather deeply placed, a high, thin lamina about one-fourth of a whorl long (seen below on the right in fig. 6). The lower palatal fold is oblique, below the inner end of the upper. There is a thin, short suprapalatal fold, not far within, at the lower edge of the sinulus. The peristome is expanded and reflected, pale brown or gray.

Length 1.95, diam. 0.85 mm.

Length 1.6, diam. 0.75 mm.

Lower California: bank of San Tomas River (type loc.; Hemphill); Point Abreogos (Hemphill, 105486 USNM); Ensenada de Todos Santos, under decaying *Mesembryanthemum æquilaterale* (C. R. Orcutt). California: around San Diego (Orcutt); False Bay, Asher Station, in drift (S. S. Berry); Mesa near Grantville, under prickly pear stems, and Pacific Beach (Orcutt). Waterman canyon, San Bernardino Co., common (Berry).

Pupa hemphilli Sterki, Nautilus, iv, July 1890, p. 27; Aug. 1890, p. 39, pl. 1, f. 6. — Binney, 4th Supplement to Terr. Moll., vol. v, 1892, p. 192, f. *a, b, c.* — *Bifidaria hemphilli* Berry, Nautilus, xxx, 1916, pp. 38, 83.—*Pupa calamitosa* part, Pilsbry, Nautilus, iii, p. 61, pl. 1, f. 6; Proc. A. N. S. Phila., 1889, p. 411, pl. 12, f. 17.

This minute species is much more complex in structure than *S. calamitosa*, with which it occurs in the Lower Californian stations. The extremes of size are represented in one of the lots from False Bay, near San Diego, 1.6 and 2.05 mm. long.

6. STERKIA CALAMITOSA (Pilsbry). Pl. 7, figs. 1 to 4.

The shell is perforate and rimate, cylindric, obtuse at both ends, thin, somewhat glossy, light brown. First 1½ whorls smooth, corneous, the rest sculptured with close rib-striæ, not quite as wide as their intervals, and somewhat less regular and close on the last 1½ than on the second whorl. There are 4½ to 4¾ whorls, the upper ones strongly convex, the last a little less so, its latter part flattened laterally, distinctly impressed over the upper palatal plica, and having a dent-like impression on the base, near the expansion of the lip. The aperture is as wide as long, obstructed by five teeth. Angular lamella slightly curved, the concavity towards the periphery, outer end reaching the lip; its summit is bilobed, there being a median depression. The parietal lamella is of about the same length, but it is higher, more deeply placed and slightly sinuous; its crest is bent towards the angular lamella. The columellar lamella is very large. It consists of a horizontal portion running forward on the parietal wall near the columella, and a broad, vertical portion descending to the base of the axis (pl. 7, figs. 3, 4). The two strong palatal folds stand rather deep within, the upper (seen in profile in fig. 1) being about twice as long as the lower. Peristome is rather broadly expanded and reflected, brown, thin; narrower, somewhat excavated in the sinulus; terminations rather remote, joined by an appressed callus.

Length 1.5, diam. .75 mm. 4¾ whorls (type).

Length 1.45, diam. .8 mm. 4½ whorls (E. de Todos Santos).

Lower California, near the mouth of San Tomas River (Hemphill, type loc.) and Ensenada de Todos Santos (C. R. Orcutt).

Pupa calamitosa PILS., Nautilus, iii, Oct. 1889, p. 61, pl. 1, fig. 7; Proc. A. N. S. Phila., 1889, p. 411, pl. 12, f. 16 (1890).

This species is related to *S. hemphilli*, but in that form the upper palatal fold is much longer, the vertical portion of the columellar lamella far less broad, and the angular lamella longer; the lower palatal fold is wholly immersed, and there are many other differences in structure, *S. hemphilli* being a more evolved species.

The two localities known for *S. calamitosa* are near together. Orcutt reports it as found under decaying *Mesembryanthemum equilaterale*. In both places it was found with *S. hemphilli*.

Genus TRUNCATELLINA Lowe.

Truncatellina Lowe, Ann. Mag. N. H. (2), ix, April 1852, p. 275, for *Pupa linearis* Lowe only; Proc. Zool. Soc. London, 1854, p. 207 (March 16, 1855), *P. minutissima* Hartm. designated as type.—v. Martens, Nachrbl. d. M. Ges., 1878, p. 38. Not "*Truncatellina* Orb., Tabl. Meth. Ceph., 1826," Scudder, Nomenclator Zool., 1882, p. 345, and Universal Index, p. 329, error for *Truncatulina* Orbigny, Ann. Sci. Nat., vii, 1826, p. 278, Foraminifera.

Isthmia Gray Reinhardt, Sitzungsber. Ges. Nat. Freunde Berlin, 1879, p. 133 (review of species and their distribution); Nachrichtsblatt deutschen Malak. Ges., 48, 1916, p. 158. — Westerlund, Fauna Pal. Reg. Binnenconch, iii, 1887, pp. 126-129. — Kobelt, Iconographie Land- und Süsswasser-Moll. (n. F.), viii, p. 83. Not *Isthmia* Gray, see Vol. XXV, p. 71. (Misspelled *Jothmia* in Beilage Jahresh. Ver. Vaterl. Naturk. Württemb. 68 Jahrg., 1912, p. 33, and *Istmia* in Paetel's Catalog, 1889.)

Laurinella Hesse, Nachrichtsbl. d. Malak. Ges. 47, 1915, p. 53 ("für die winzigen Schnecken der *minutissima*-Gruppe"); *Pupa minutissima* auct. = *cylindrica* Fér. here selected as type.

The shell is minute (1.2 to 2.5 mm. long in known species), cylindric, with obtuse, rounded summit, and short, strongly convex whorls. Aperture ovate, without defined sinulus, the lip narrowly expanded, often thickened, outwardly a little straightened; having one to three teeth (parietal, columellar and lower palatal), or none; the columellar and lower palatal more or less *deeply immersed* when present.

Animal without inferior tentacles. The shell is carried nearly upright.

Type: *T. linearis* (Lowe). Distribution: Palæarctic and Ethiopian regions; living under stones and wood.

This genus of minute snails has a wide but apparently discontinuous distribution. It is found on the Atlantic Islands, fossil only in Madeira, living in the Canaries and Cape Verdes; throughout Europe except in the far north, and in Asia eastward to the western Himalayas, with a remote outpost in the central Loochoo Is. In Africa there is a herd in the Abyssinian highlands, some scattered species in British East Africa, and in South Africa it becomes abundant again. Yet but little collecting of minutiæ has been done in tropical Africa, where the genus may have a greater range.

The absence of inferior tentacles has been repeatedly observed in Europe, for both toothless and tridentate species. Mr. Burnup informs me that South African species he has examined alive lack inferior tentacles.

The blunt teeth, never more than three, with the columellar lamella oval, axially lengthened instead of entering spirally, are characteristic; also the invariable deep immersion of the palatal fold, from one-third to two-thirds of a whorl inward from the lip. The teeth are rather more like those of *Pupilla* than like other genera of *Vertigininæ*.

As in other land shells of cylindric shape, the *length* is often quite variable, sometimes even in the same colony; the diameter remaining more constant. In the writer's measurements the diameter is measured to the edge of the lip; more conservative quantities would be obtained by measuring above the aperture.

Palaeontology of Truncatellina.

The record begins in the Upper Oligocene of Germany and northern Bohemia, with both smooth and rib-striate species having teeth like the recent *T. claustralis*. Others followed in the Miocene, and it will doubtless be turned up in the Pliocene of southern Europe. The earliest known forms appear to be in the same stage of evolution as the Recent toothed species. When really early stages of the genus are recovered, they may be expected to possess angular and upper palatal teeth also, with the palatals less immersed. The toothless modern species are the most evolved of the genus. References

to fossil species follow. Various Pleistocene species are included with the Recent forms.

TRUNCATELLINA SPLENDIDULA (Sandberger). *Pupa splendidula* Sandb., Vorwelt, 1875, p. 397. — *Isthmia splendidula* (Sdgr.) Boettger, Jahrb. Nassau. Ver. Nat. Jahrg. 42, 1889, p. 272, pl. 6, f. 9. — Fischer and Wenz, Jahrb. Nassau. Ver., 1914, p. 93.—*Pupa cryptodus* var. *laevis* Al. Brn. MS. Upper Oligocene Landschneckenkalk von Hochheim. A smooth, 3-toothed species, resembling *salurnensis* Reinh.

TRUNCATELLINA CRYPTODUS (Al. Braun). *Pupa cryptodus* Al. Br. in Walchner's Geognosie, 2d edit., p. 148. — Sandberger, Vorwelt, p. 396.—*Isthmia cryptodus* (Al. Br.) Boettger, Bericht Senck. Ges., 1883, p. 267, pl. 4, f. 7; Jahrb. Nassau., p. 274. Upper Oligocene Landschneckenkalk von Hochheim; northern Bohemia. Lower Miocene, Germany. Near *T. lardea* and *T. strobeli* (*rivierana*). This name has also been quoted *P. cryptodonta*. I have not consulted the original publication.

TRUNCATELLINA LENTILII (Miller). *Pupa (Isthmia) lentilii* Mill., Jahresh. Württemb. Nat. Ver., 1900, p. 406. — *Isthmia lentilii* Miller, Jooss, Nachrbl. d. Mal. Ges. 44, 1912, p. 37, pl. 2, f. 6–6*b*. Upper Miocene, Steinheim. Related to *T. claustralis*, also *rivierana*.

TRUNCATELLINA MIOCAENICA (Clessin). *Pupa (Isthmia) miocaenica* Cl., Ber. naturw. Ver. Regensburg, xiii, Heft, 1912, p. 106. Middle Miocene, Undorf. A toothless species.

TRUNCATELLINA MINUTULA (Clessin). *Pupa (Isthmia) minutula* Clessin, Ber. naturw. Ver. Regensburg, xiii, 1912, p. 106. Middle Miocene, Undorf.

Classification.

Grouped by the teeth, Truncatellinæ arrange themselves as follows:

Having a parietal lamella or tooth.

3-toothed: species in Europe, Abyssinia, South Africa.

No parietal tooth.

Having palatal or columellar teeth or both: species in Europe, Loochoo Is., S. Africa.
Without teeth: species in the Atlantic islands, Europe, western Himalayas (and S. Africa?).

In the following account the sequence is geographic:

I. Atlantic islands: species 1-3.
II. Europe, N. Africa, nearer Asia: species 4-16.
III. Japan: species 17.
IV. Abyssinia: species 18-21.
V. Central Africa: species 22, 23.
VI. South Africa: species 24-29.

Note on the literature of Truncatellina.

The first notices of *Truncatellina* species were under the name *Helix muscorum* Müller, 1774, and *Pupa muscorum* Draparnaud, 1801. It was supposed to be the Linnean species, now known to be a Pupilla. Draparnaud's *muscorum* was a composite of the toothless species since generally but wrongly known as *minutissima* Hartm., and a toothed form (which he figured), surmised with considerable probability to be *strobeli* Gredl. = *rivierana* Bens., but not positively identified by any author, though studied by many. This toothed form was renamed *Pupa minuta* by Studer, 1820. The same author also named a *P. unidentata*. Whether he actually had Draparnaud's species cannot be determined. In 1821 Hartmann defined a dentate Swiss form as *Pupa minutissima*, but so inexactly that it is not recognizable with certainty. The original documents on these and other names of the semi-mythical period are given under *T. rivierana*. Férussac, in 1821, gave the name *V. cylindrica* to the toothless component of Draparnaud's *P. muscorum*.

Scientific work of an exact nature began with Küster, Gredler, and their successors, Boettger, Westerlund, and especially Reinhardt. The last author has considered the species of Continental Europe and the Caucasus region in two interesting and lucid papers: Die Isthmia-Arten und ihre geographische Verbreitung, 1879, and Einige Bemerkungen über Pupa minutissima und Verwanten, 1916.

The Abyssinian species are still known solely by Jickeli's excellent work.

Most South African forms were at first inadequately or incorrectly described and figured, but Burnup has brought them to scientific knowledge by clear descriptions and excellent figures.

"*P. sitella* Kstr. Mscr., Triest" was mentioned by Westerlund, Malak. Blätter, xxii, 1875, p. 126, in a list of the species of "*Isthmia*". In the Fauna, 1887, he states that it is not otherwise known to him.

I. The Atlantic Islands (Madeira, Canaries, Cape Verdes).

These species are toothless, like the continental *cylindrica* group. The writer has seen *T. linearis* only.

1. Truncatellina linearis (Lowe). Pl. 8, figs. 1, 2.

Shell minutely, distinctly umbilicate, narrowly elongate-cylindric or linear-oblong, very obtuse at both ends, the apex as if decollate-truncate; elegantly and beautifully closely striate; whorls 6-7; rather tumidly convex, 4 or 5 last equal; suture impressed. Aperture rather widely rotund-oval, a little longer than wide, scarcely one-fourth the total length; peristome rather simple, very narrowly reflected, the lip slightly sinuate above (*Lowe*).

Length 1.5 to 2, diam. ⅔ to ¾ mm.; aperture ⅓ to ½ mm. long; 6-7 whorls (*Lowe*).

Length 1.4 to 1.5, diam. 0.83 mm.; 5½ whorls.

Madeira: Pleistocene in the shell bed at Canical.

Pupa linearis Lowe, Ann. Mag. N. H. (2), ix, April 1852, p. 275; Proc. Zool. Soc. Lond., 1854, p. 207. — Wollaston, Testacea Atlantica, 1878, p. 207.—*Pupa minutissima* Hartm., Watson, Journ. de Conchyl., 1876, p. 223.

Wollaston notes that "like most of the Pupæ it has a longer and a shorter state, some examples appearing to possess a volution more than the others." Only this shorter phase is before me (figs. 1, 2). Compared with *T. cylindrica*, the ribs are more widely spaced, half to a fourth as wide as the intervals. There is no trace of a crest behind the outer lip,

but the ribs are larger and more spaced there. The aperture is toothless.

2. TRUNCATELLA ATOMUS (Shuttleworth).

Shell very minute, rimate, cylindric, obtuse, very elegantly and finely costulate, thin, pellucid, corneous. Whorls 5½, convex, the last nearly one-third the total length. Aperture oblong, toothless; peristome very delicately reflected, the superior margin obtusely angulate, columellar margin dilated. Length scarcely over 1¼, width ⅔ mm.; aperture about ⅓ mm. long (*Shuttl.*).

Canary Is.: Teneriffe, found under leaves (Blauner).

Pupa atomus SH., Diagn. neuer Moll., i, p. 10, in Mittheil. Bern., 1852, p. 144. — PFR., Monogr., iii, 532.—WOLLASTON, Testacea Atlantica, 1878, p. 448.

"Near to *P. minutissima* [*T. cylindrica*], but smaller, sharply costulate and with fewer whorls" (*Shuttl.*). It needs comparison with the small form of *T. linearis* of Madeira. It is known by the original account only.

3. TRUNCATELLINA MOLECULA (Dohrn).

Shell very minute, deeply rimate, cylindric, obtuse, slightly striatulate, pellucid, corneous. Whorls 4 to 5, convex, the last about ⅔ the length. Aperture subcircular, toothless; peristome a little reflected, the right margin arcuate above. Length scarcely 2, diam. 0.8, diam. apert. 0.75 mm. (*Dohrn*).

Cape Verde Is.: S. Antao.

Pupa molecula DOHRN, Malak. Bl., xvi, 1869, p. 13.—PFR., Monogr., viii, 362.—WOLLASTON, Testacea Atlantica, 1878, p. 512.

Nearly related to *Pupa minutissima* and *P. atomus* Sh., but differs from both by the nearly smooth shell as well as by the somewhat more rapidly increasing whorls, giving the last a different ratio to the shell length. In collecting the small Pupæ, which were all covered with hard dirt, I at first overlooked this species, and only about 20 specimens were afterwards found (*Dohrn*).

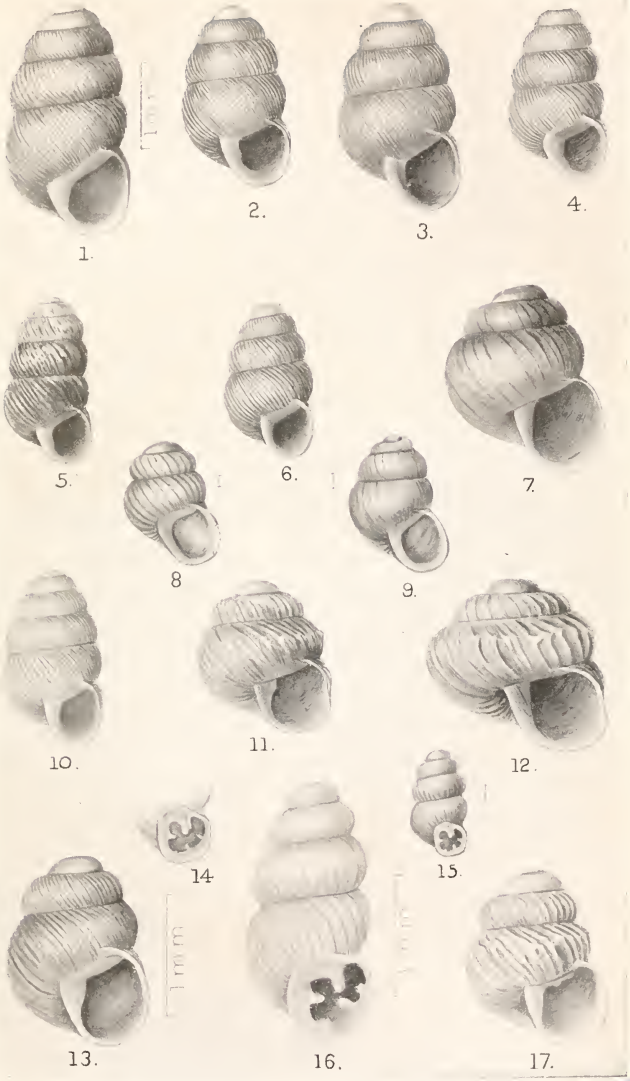
There is an unexplained discrepancy in the accounts of

Dohrn and Wollaston as to the sculpture. Wollaston writes as follows of specimens received from Dohrn: "The extremely minute size and linear outline of this little Pupa, added to its remarkably convex or tumid volutions (which are coarsely and very obliquely striated), its thin substance, its pale whitish-brown, or almost brownish-white, hue, and but slightly shining surface, and its perfectly edentate aperture, will prevent it from being confounded with any other member of the genus from at all events the Cape Verde archipelago. It possesses, however, a peculiar interest geographically from its being so nearly allied to a subfossil species, the *P. linearis* Lowe, from Madeira, which has not yet been met with in a recent state, that before I had made close comparison I thought it most probable that the two would prove to be identical. However, although so intimately related, I feel sure, after an accurate examination, that they must be treated practically as distinct; for not only is the *P. molecula*, on the average, a trifle larger and broader than the *linearis*, but its volutions are perhaps even still more tumid, its suture is more oblique, or less horizontal, and (which is the most important of all) its aperture is appreciably larger and more developed."

II. Species of Europe, North Africa and nearer Asia to the western Himalayas.

Key to species of Northern Africa, Europe and Western Asia.

1. Aperture without teeth. ..... 2.
   Aperture having teeth (sometimes deeply immersed) .. 6.
2. Almost smooth, the striæ very minute; 1.25 x 0.5 mm., 6 whorls; Triest to Hungary. .....*T. laeviuscula*, no. 6.
   Surface rib-striate. ..... 3.
3. Shell slightly wider above; 1.5 mm. long. ..... 4.
   Shell tapering slightly upward; 2 mm. long, 7-8 whorls; Transcaucasus. .....*T. micula*, no. 8.
   Shell cylindric; length 1.5 to 2.2 mm. ..... 5.
4. Five whorls; closely rib-striate; Tunis. *T. doumeti*, no. 5.
   Six whorls; sharp, spaced ribs; Athens, Palestine. *T. rothi*, no. 7.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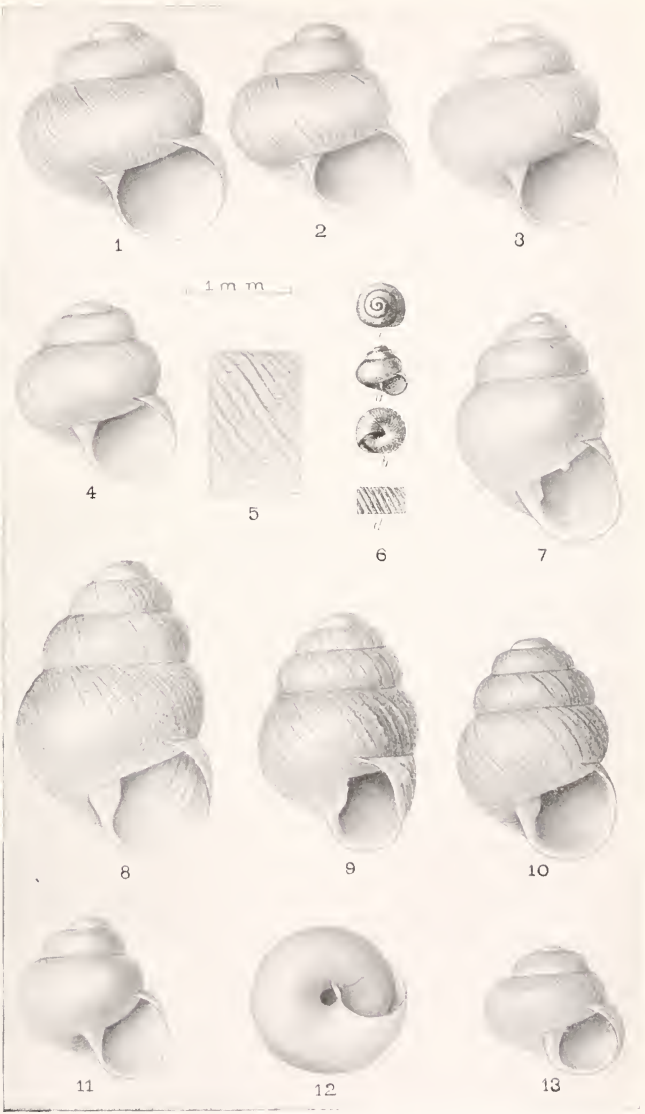
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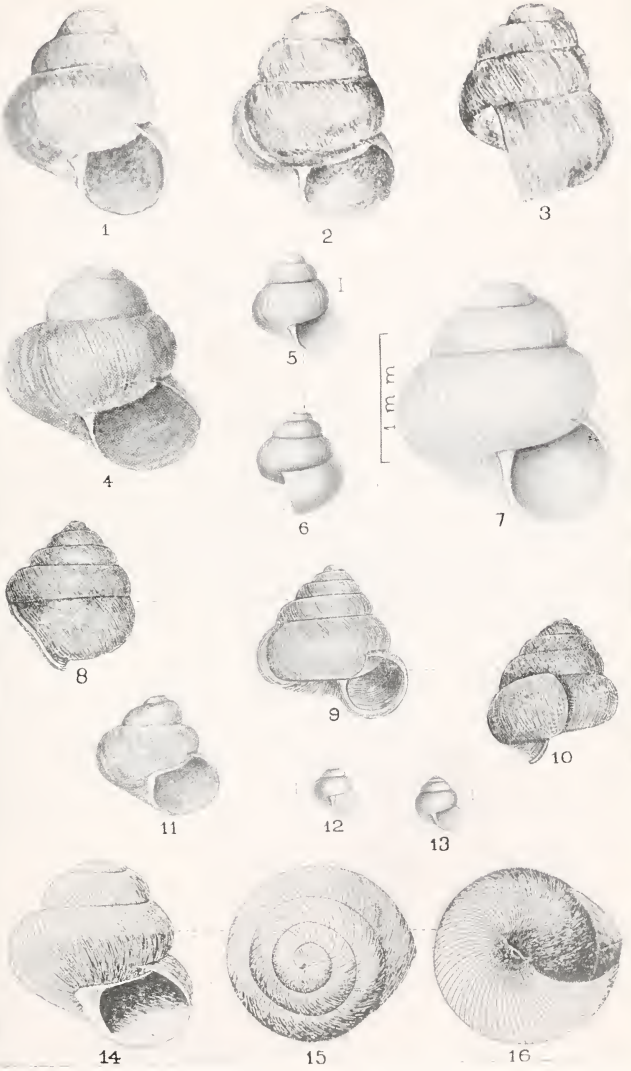
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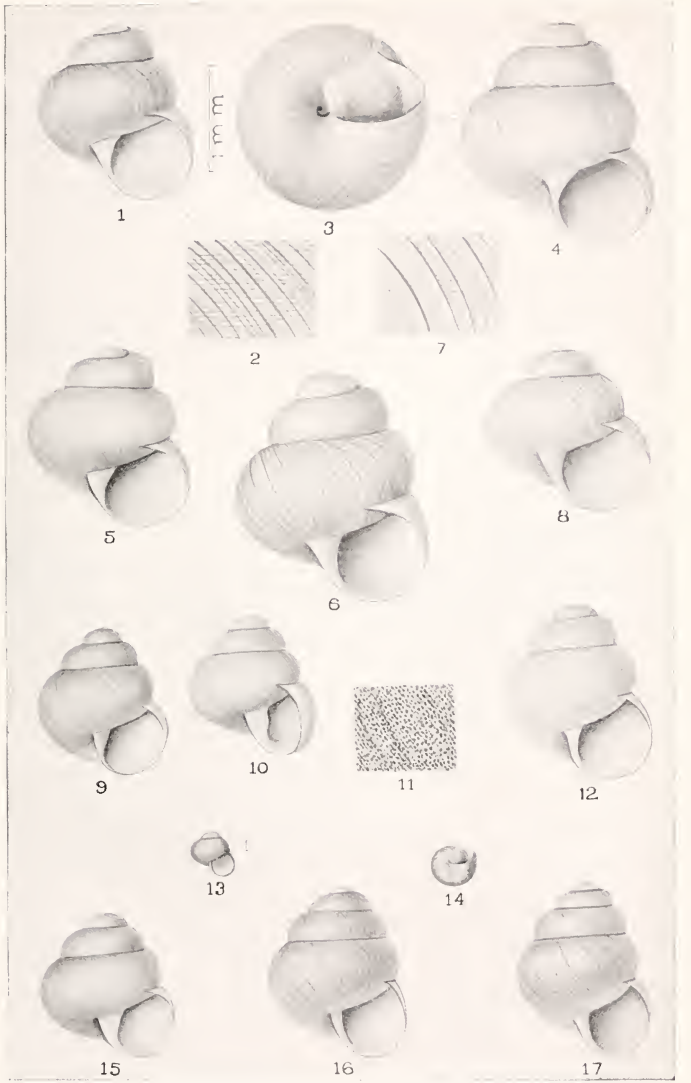
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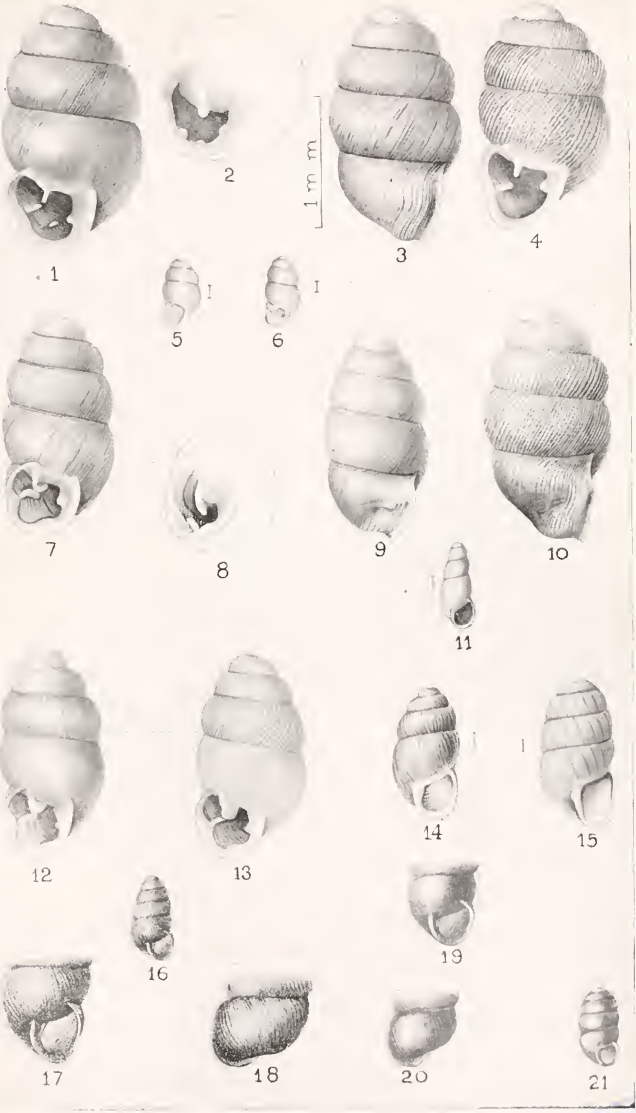
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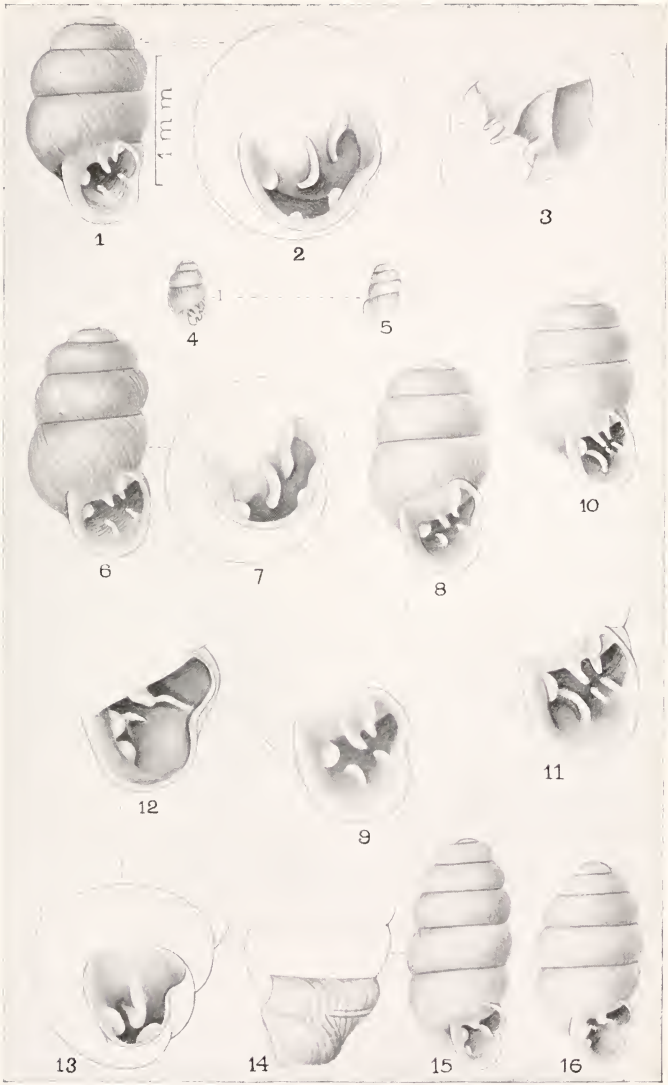
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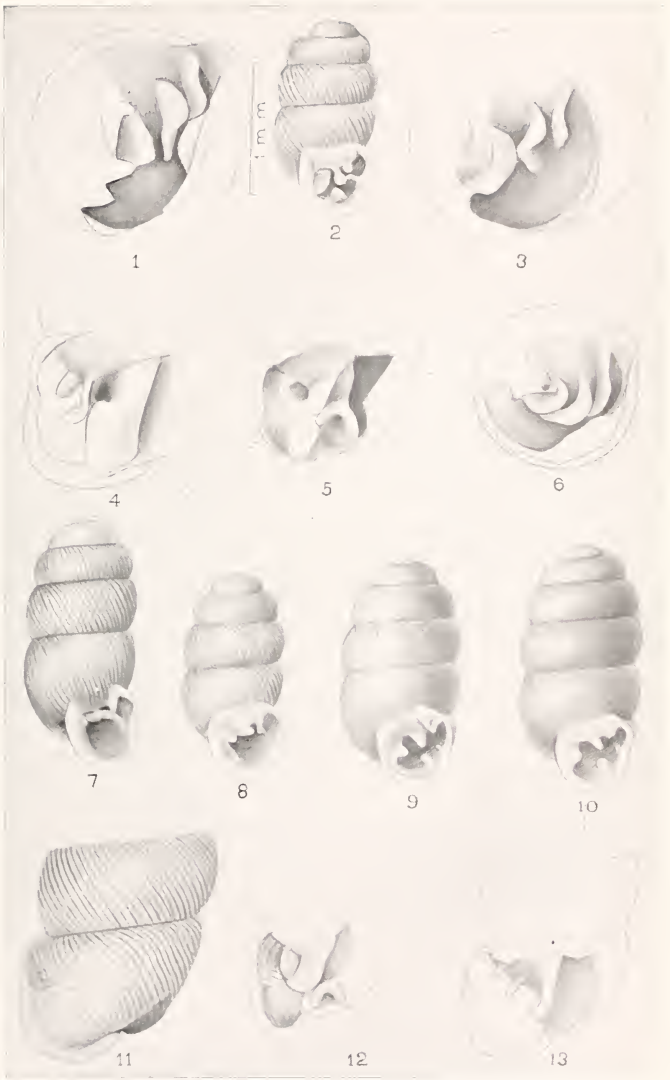
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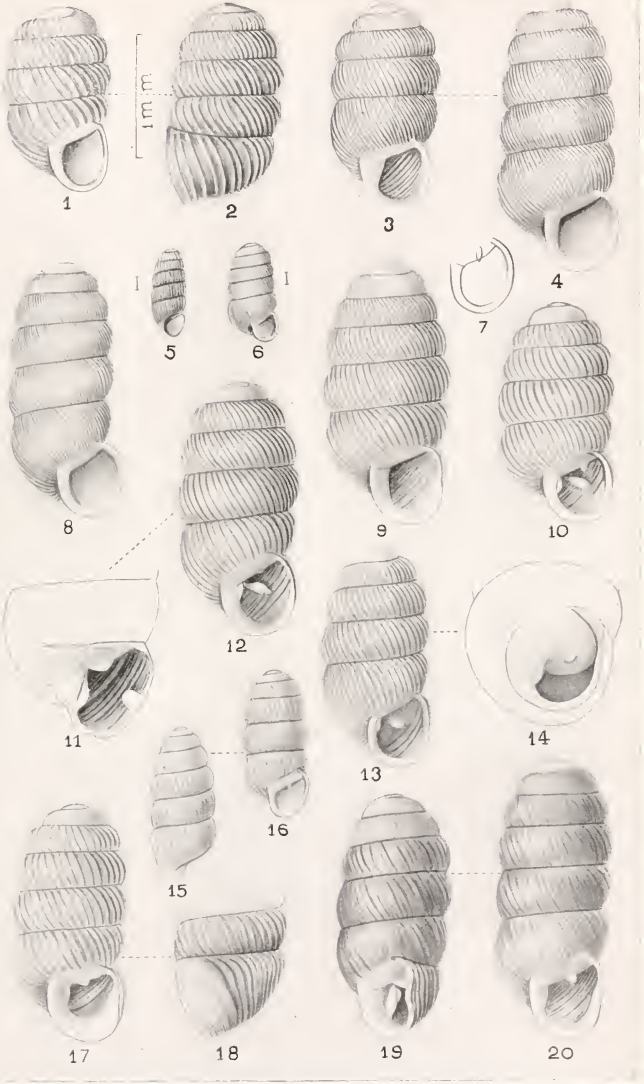
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5. 1.6 to 2.2 mm. long, 5½ to 6½ whorls; Europe, etc. *T. cylindrica*, no. 4.
   2 x 1 mm., 7 whorls; western Himalayas. *T. himalayana*, no. 9.
6. Three-toothed, the palatal tooth visible in a direct front view. ..... 7.
   Palatal tooth further in, not visible in a direct front view. ..... 8.
7. Teeth high, rather large; length 1.7–2 mm.; Mediterranean region, etc. ..... *T. rivierana*, no. 10.
   Teeth small, low; length 1.65–1.75 mm.; England. *T. brittanica*, no. 11.
8. No parietal lamella or tooth; sharply ribbed; Triest. *T. uniarmata*, no. 15.
   Parietal minute, punctiform, palatal near the suture; Norway. ..... *T. odontostoma*, no. 12.
   Parietal lamella elongate or lamelliform, though sometimes low. ..... 9.
9. A massive, rounded crest behind the lip, which is heavily white-calloused within; Sweden to North Germany; Caucasus. ..... *T. costulata*, no. 13.
   Crest wanting or inconspicuous; lip not heavily calloused. ..... 10.
10. Surface merely finely striate; Tyrol, etc. ..... 11.
    Surface closely ribbed; southern France to Caucasus. *T. claustralis*, no. 14.
11. 2–2.25 mm. long, 6 whorls; Tyrol, etc. *T. monodon*, no. 15.
    1.5–1.6 mm. long, 6½ whorls; Tyrol. *T. c. salurnensis*, no. 14*a*.

(*Group of T. cylindrica.* Aperture toothless.)

4. TRUNCATELLINA CYLINDRICA (Fér.). Pl. 8, figs. 1-4, 8.

The shell is minute, cylindric with obtuse summit, cinnamon-colored or paler, rather glossy, finely and closely rib-striate except the first whorl. First 2½ whorls forming the summit widen rapidly, the following 3 to 4 whorls slowly, forming the cylindric portion; the latter part of the last whorl tapers towards the base. The aperture is shortly ovate,

slightly oblique; without teeth. The whitish peristome expands a little and is somewhat thickened within, the terminations joined by a thin callus.

Length 2.13, diam. 0.9 mm.; 6½ whorls. France.

Length 1.95, diam. 0.87 mm.; 6 whorls. Auxonne.

Length 1.63, diam. 0.8 mm.; 5½ whorls. Auxonne.

Length 1.65, diam. 0.80 mm.; 6 whorls. Auxonne.

Length 1.75, diam. 0.8 mm.; 6 whorls. Tyrol.

Length 1. 85, diam. 0.82 mm.; 6 whorls. Dorset.

Europe; North Africa in Morocco and Tunis; Crimea; Asia east to the Caucasus.

Pupa muscorum, a, Drap., Hist. Nat. Moll. terr. et fluv. de la France, 1806, p. 59, pl. 3, f. 26, 27, in part. Not of Linné. —*Vertigo muscorum* Moquin-Tandon, Hist. Moll. Fr., 1855, p. 399, pl. 28, f. 22, 23.—Bourguignat, Malac. de l'Algerie, ii, 1864, p. 98, pl. 6, f. 28-30 (debris of the Harrach and Rassauta near Algiers).—*Isthmia muscorum* Loc., Letourneux et Bourguignat, Prodr. Malac. Tunisie, 1887, p. 109 (Algeria: Harrach, Algiers, Bou-Saada, Bone).

Vertigo cylindrica Férussac, Tabl. Syst., 1821, p. 64.— *Isthmia cylindrica* Fér., Reinhardt, Nachrbl. d. Malak. Ges., vol. 48, 1916, p. 68.

Pupa minutissima Hartm., of most authors; Pfr., Monogr., ii, 306; iii, 532; iv, 663; vi, 301; viii, 362. — Küster, Syst. Conch. Cab., p. 100, pl. 14, f. 6-8. — Morelet, J. de Conch., xxviii, p. 61 (Tanger, Morocco).—Hidalgo, J. de C., xxvi, p. 242 (Balearic Is.; apparently includes *rivierana*). — Rossmaessler, Iconographie, i, pt. 1, p. 84, pl. 2, f. 38.—Jeffreys, British Conchology, i, p. 270.—*Pupa minutissima* var. *angustata* Mouss., Kobelt, Catalog eur. Faunengeb. leb. Binnenconch., 1871, p. 32 (Epirus; nude name). — *Pupa (Isthmia) minutissima* Hartm., Boettger, Jahrb. d. m. Ges., x, 1883, p. 183; vi, 406; vii, 139 (Caucasus). — *Isthmia minutissima* (Hartm.) Boettger, Jahrb. Nassau. Ver. Nat., 42, 1889, p. 275 (distribution, Pleistocene and Recent).—Steenberg, Danmark's Fauna, Landsnegle, 1911, p. 171, f. 141.

This is the most widely distributed species. Its northern limit has been roughly defined by the localities Skye, Christi-

ania and Moscow. From the Atlantic (Portugal) it extends eastward to the Caucasus region. *T. himalayana* appears to be an eastern representative of *cylindrica*.

It varies widely in size, short examples occurring rather numerously in some lots. French specimens figured measure:

Length 2.1, diam. 0.9 mm.; 6⅔ whorls.

Length 2, diam. 0.85 mm.; 6½ whorls.

Length 1.57, diam. 0.75 mm.; 5⅓ whorls.

There is also some variation in shape. Moquin-Tandon has noted a mut. *albina*, shell entirely whitish, Jura and Pyrenees (Hist. Moll. Fr., ii, 399).

English specimens seen are below the maximum size, being slightly less than 2 mm. long.

D. Geyer has recorded cases of gigantism, specimens having 1 to 2 additional whorls, the lip remaining unfinished, or with an inflated supernumerary seventh whorl (Nbl. d. M. Ges., 1912, p. 122).

Férussac's name *Vertigo cylindrica* was based upon *Pupa muscorum* of Draparnaud's *Histoire*, but with the qualification *"bouche sans dents"*. He notes a variety *"a*, apertura sub unidentata, major?" Draparnaud had said that there is often one or sometimes even two low folds. He distinguished two forms, *a*, aperture toothless, and *b*, aperture 1-2-toothed; figuring one of the latter. It is evident that Draparnaud had more than one species: the *cylindrica* (commonly known as *minutissima*), together with *rivierana* or an allied dentate form from somewhere in the south of France.

T. cylindrica obscura (Mousson).

Shell elegantly striate, permanently covered with a dark epidermis. Whorls 6, the spire cylindric from the third. Margin scarcely reflected, dark; aperture toothless (*Mousson*).

Greece: Janina.

Pupa minutissima Hartm. var. *obscura* Mss., Coq. rec. par Schlaefli, in Vierteljahrschrift der Naturf. Ges. Zurich, iv, 1859, p. 272 (46 of separate copies).

The differences from the typical form consist in the permanence of the deep brown epidermis, matt, masking the rib-

striæ; the much more obtuse summit, not beginning to taper until the fourth whorl from the aperture; finally by the aperture without trace of teeth and with thick, dark margin (*Mousson*).

5. Truncatellina doumeti (Let. et Bgt.).

The shell is very minute, very narrowly perforate, short, cylindric, more swollen at summit than at base, fragile, subdiaphanous, corneous, well striated obliquely. Spire short, very obtuse at summit, rounded dome-like. Whorls 5, convex (the embryonic minute, paler), rather slowly increasing, separated by a deep suture, the last moderate, convex, margin lightly flattened outwardly, tapering at base, straight above at the insertion. Aperture very oblique, receding below, lunate, semiovate, toothless; peristome a little thickened, spreading and whitish; columellar margin strong, reflexed; margins remote. Length 1.5, diam. 0.75 mm. (*L. & B.*).

Tunis: drift debris of the Oued Sidi-Aich (Let.).

Isthmia doumeti Letourneux et Bourguignat, Prodr. Malac. Tunisie, 1887, p. 110.

6. Truncatellina laeviuscula (Kuester). Pl. 8, figs. 6.

The almost lacking rib-striæ are perceptible as fine lines only under strong magnification; it is also usually somewhat slimmer [than "*minutissima*"] (*Kuester*).

Triest, under stones on the grassy slope below the church of Servola (*Kuester*); also east to Serbia and Banat.

Pupa laeviuscula K., Syst. Conchyl. Cab., p. 101, pl. 14, f. 6-8; as a var. of *P. minutissima*.—Reinhardt, Nachrichtsbl. d. M. Ges., vol. 48, 1916, p. 162.—*Pupa minutissima* var. *sublaevigata* Pfr., Nomencl. Hel. Viv., 1878, p. 356, substitute for *laeviuscula* Küster.

Dr. Reinhardt found specimens agreeing well with Küster's species near the Hercules-bade (on the way to the Domogled and on the right bank of the Czerna). He gives the following description:

"Shell cylindric, less obtuse above than *cylindrica* (not until the 4th whorl as wide as the next), yellowish-brown,

with an oily luster; nearly smooth, only under the lens showing fine, close, hair-like striæ,* which become somewhat more distinct immediately preceding the aperture. Whorls 6, rather ventricose, separated by moderately deep suture, the 3d to 5th very gradually increasing, the last about ¼ to ⅓ the total length, somewhat ascending to the aperture. Aperture roundish, especially rounded below, as high as wide, the outer margin obtuse-angularly bent inward, somewhat produced forward below the angle, and inclined to be thickened. Columellar margin somewhat expanded and a little reflected towards the round, open umbilicus. Peristome distinctly white-lipped. Length 1¼, width ½ mm.

"Differs from *cylindrica* by the smaller size, less obtuse apex, the smoothness and gloss and the somewhat stronger-lipped, more rounded aperture. The general appearance is diverse. Very small full-grown specimens are found, of scarcely 1 mm. length. On weathered specimens the striation is somewhat more distinct.

"*Isthmia laeviuscula* appears to be a form of the eastern Alps and Balkans. East of Triest it occurs in Carinthia, in Serbia (v. Moellendorff), in Hungary (Ministal between Steierdorf and Baniaska), finally in Banat, near the Herculesbade."

Pfeiffer used the term *sublaevigata* as part of the *description* of var. *b*, *Pupa laeviuscula*, in the *Monographia*, ii, 1848, p. 307, but in the *Nomenclator*, 1878, that term is adopted as a name for Küster's form.

7. Truncatellina rothi (Reinhardt).

Shell very obtuse (the 3d whorl from above as wide as the following), almost diminishing downwards. Whorls 6, convex, little ascending, parted by a pretty deep suture, the embryonic whorl smooth, the rest having sharp, spaced ribs, running from the left above to the right below, the intervals wider than the ribs. The three middle whorls (or at least the

* Kuester wrote me: "If a distinct species, I would rather call it *capillacea*." I regret that this excellent name cannot be used for reasons of priority (*Reinhardt*).

4th and 5th) about equally high, the last little higher, occupying about ¼ to ⅓ the total height. Aperture roundish, but little higher than wide, the outer margin roundly bowed inward, and below that with weak indication of an inbending. Peristome little expanded. Umbilicus open, round, but little covered by the columellar lip. Length 1.5, diam. 0.5 to 0.75 mm. (*Reinh.*).

Greece: around Athens (Roth). Lake Tiberias (Hesse).

Pupa minutissima Roth, Spicil. Moll., 1855, p. 24.—*Isthmia rothi* Reinhardt, Nachrbl. d. Mal. Ges., vol. 48, 1916, p. 164.

Differs from *cylindrica* Fér. by the compact structure, the peculiar form, wider above, the sharp, widely-spaced striation, more convex whorls and deeper suture.

8. Truncatellina micula (Mousson).

Shell minute, perforate, tapering-cylindric, very delicately rib-striate, without gloss, brownish-gray. Spire slowly tapering, the summit shortly conic, obtuse; suture a little impressed. Whorls 8, the first convex, following somewhat flattened, the last somewhat inflated, a little ascending, rounded, not compressed basally. Aperture subvertical (making an angle of 10° with the axis), less than one-fourth the total length, truncate-subcircular, at base shortly curved, without teeth. Peristome but slightly expanded, thinly white-lipped, rather obtuse, the margins remote, right margin a little excurved at the insertion, columellar margin slightly reflected. Length 2, diam. 1 mm.

Transcaucasus: Mahmutli (Sievers).

Pupa (Pupilla) micula Mouss., Journ. de Conchyl., xxiv, 1876, p. 40.—Pfr., Monogr., viii.

It differs from "*minutissima,*" according to Mousson, by the form, a slightly conic cylinder, the large number of whorls and their slight convexity.

Reinhardt has provisionally identified specimens from the drift of the Maritza at Philippopolis, Bulgaria, as this species. They have 7 whorls, and measure, length 2.5 to 2.7, diam. 1.1 mm.

9. Truncatellina himalayana (Bens.). Pl. 8, figs. 5, 9.

Shell rimate-perforate, ovate-oblong, subcylindric, obliquely most minutely costulate, translucent, pale corneous; spire oblong, apex obtuse, suture impressed; whorls 7, short, convex, the last slightly ascending in front. Aperture rounded-ovate, toothless; peristome thin, the margin a little expanded, right margin slightly running forward above. Length 2, diam. 1 mm. (*Bens.*).

Western Himalayas: Simla and Mussoorie (Hutton); Panjal Range, Kashmir (Theobald); Jhelum Valley and Pir Panjal; also from Naini Tal, Mussoorie and Simla (Godwin-Austen).

Pupa himalayana Hutton, Benson, Ann. Mag. N. H. (3), xii, 1863, p. 428.—Hanley & Theobald, Conch. Indica, 1875, pl. 101, f. 4. — Theobald, Journ. Asiatic Soc. Beng., xlvii, 1878, p. 146. — Godwin-Austen, Proc. Malac. Soc. Lond., iii, 1899, p. 262.—*Sphyradium himalayanum* Bens., Gude, Fauna of British India, ii, 1914, p. 41 (*Columella himalayana* on p. ix).

The specimen from Simla figured (fig. 9) measures: length 2.05, diam. 0.97 mm., 6½ whorls. Except by being more fragile and not quite so strictly cylindric, I see little to differentiate it from some European *T. cylindrica*, though the riblets are spaced a trifle wider than usual in that species. The original figure is copied in fig. 5.

Though remote from the ascertained range of *cylindrica*, it is likely that the genus will be found in the intermediate territory of Persia and Afghanistan.

(*Group of T. rivierana.* Aperture having one to three teeth.)

10. Truncatellina rivierana (Benson). Pl. 8, figs. 10, 11, 12.

Shell rimate-perforate, exactly cylindric, diaphanous, rather glossy, most minutely, obliquely rib-striate; suture deep; apex obtuse. Whorls 6½, convex, the last one-fourth the total length, slightly ascending in front, a trifle compressed around the base. Aperture truncate-ovate, 3-plicate, oblique; peristome simple, margins separated, acute, whitish, the margins a little expanded, the outer strongly arcuate above, the inner

lip somewhat reflected. There is a single fold in the middle of the parietal margin, an oblique, blunted brown one on the columellar margin, the palatal fold lengthened, whitish, forming a groove externally; all of them deeply placed. Length 2, diam. ⅔ mm. (*Bens.*).

Mediterranean region, Algeria, southern France, Switzerland and the Tyrol, Italy and Sicily, Caucasus, Persia.

Pupa rivierana Benson, Ann. Mag. N. H. (2), xiii, 1854, p. 97 ("Riviera regione Pedemontana, ad basin collium prope Nizza maritimam sub lapide." Also found by Mr. John Paget at Montpellier).

Pupa strobeli Gredler, Verh. zool.-bot. Vereins in Wien, vi, 1856, p. 114, and of many subsequent authors.—*Isthmia strobeli* Gredl., Rosen, Nachrbl. d. Mal. Ges., 1892, p. 126 (Germab and Chorossan, 10 kilom. w. from Schamhala, Persia).—*Pupa (Isthmia) strobeli* Gredl., Boettger, Jahrb. d. Mal. Ges., vi, p. 405 (Caucasus, etc.); Nachrbl., xi, 1877, p. 66 (distribution).—Kobelt, Iconographie (2), viii, p. 83, pl. 234, f. 1514. — *Pupa strobeli* var. *scharffi* Boettger, Nachrbl. d. Mal. Ges., 1879, p. 51.—Scharff, Journ. of Conch., ii, 1879, p. 291.

Vertigo muscorum var. *triplicata* Bourguignat, Malac. de l'Algerie, ii, 1864, p. 99, pl. 6, f. 31-32 (Bone; around Algiers). — *Pupa mystica* Pils., Sterki, Nachrbl., xxi, 1889, p. 119, as synonym of *strobeli*.

Helix zanellia Testa, Benoit, Ill. sist., crit. Test. estramar. Sicil. (1858?), p. 195, pl. 5, f. 10; *cf.* Reinhardt, Jahrb. d. Mal. Ges., 1877, p. 277.

Generally distributed in the "olive zone," though extending beyond it in Switzerland and eastward; for a long time confused with *T. cylindrica*, but readily known by the teeth, of which the palatal tubercle is visible from in front, not concealed behind the columella as it is in *T. claustralis*. French specimens measure:

Length 2, diam. 0.9 mm.; 6⅓ whorls.

Length 1.74, diam. 0.83 mm.; 6¼ whorls.

Length 1.7, diam. 0.8 mm.; 6 whorls.

Pupa strobeli Gredler is clearly the same species, and it has almost universally been known by this name. Gredler's description follows.—Shell very small, cylindric, of almost equal breadth, obtuse above; very finely and regularly rib-striate, with silky luster, rather translucent light horn-color or reddish yellow. Whorls 5 or 6, convex, low, parted by a deeply constricting suture, the last whorl often scarcely noticeably compressed around the funnel-shaped umbilicus and on the neck towards the rounded base. Aperture rounded ovate, generally 3-toothed: 1 somewhat curved and fold-like tooth on the parietal wall, running inward, a smaller tooth on the columella, and a drop-shaped tooth (in old examples often prolonged inward) in the palate, and externally visible on the neck. Peristome outwardly arched, but little thickened, the terminations joined by a glossy callus (*Gredler*). Type loc., Klausen, southern Tyrol, on the garden hill of the Capuchin Fathers, under moss on sandy soil (Gredler); also generally distributed in that country.

Ill-defined forms related to rivierana.

Various ill-defined names in the literature may have been based upon *T. rivierana, T. claustralis* or nearly related forms. Some French and Italian records of *muscorum* Drap. and *minutissima* Hartm. also included *rivierana,* judging from the remarks as to presence of teeth. Most of these names (including *T. callicratis* Scacchi) are anterior to the names *rivierana, strobeli* and *claustralis.* By thorough collecting in the type localities, no doubt most of them could be recognized with a certain degree of probability; yet the descriptions are so inadequate that in my opinion later recognizably defined names should not be displaced.

Pupa minuta Studer was defined thus: [*Pupa*] *minuta* Drap., iii, f. 26, 27. *P. muscorum* der Franzosen. Von Venetz in Wallis und von Charpentier bey Bex gefunden (*Studer,* Naturwiss. Anzeiger der allg. Schweizerischen Ges. für die gesammten Naturwissenschaften, No. 11, May 1, 1820, p. 89). It was placed by Studer in the division of *Pupa* with "gezähnte Mündung", and was probably a form of *rivierana.*

Pupa minutissima. — Ganz Fassförmig, länglich, die Umgänge sehr anpassend; die ganze Länge beträgt nur ½‴ auch ist die Schaale dünne. Die Mündung enhält einen Zahn. Sie

findet sich in der Schweiz (Hartmann, in Neue Alpina, i, 1821, f. 220, pl. 2, fig. 5).

The figure is so small and indistinct that it is quite useless. Whether the species is identical with *T. rivierana* cannot be determined positively; the assigned size is too small.

Vertigo pupula Held, Isis, von Oken, 1837, p. 308, nos. 15 and 1, was a substitute for *Pupa minutissima* Hartm., without other description. Bavaria.

"[*Pupa*] *pusillima* Zgl. (*P. minutissima* Hartm.?)." Menke, Synops. meth. Moll. Mus. Menkeano, 1828, p. 18. It has not been further defined.

[*Vertigo muscorum* Drap.] Var. dentiens Moq. (Pl. 8, fig. 7, copied from Moq.-Tand.). Aperture with 1, rarely 2 tooth-like folds on the middle of the penult whorl. Toulouse, Montpellier (Moquin-Tandon, p. 399, pl. 28, f. 24). Probably = *T. rivierana* or var. *scharffi*.

Little-known Italian forms of the T. rivierana series.

Vertigo monodonta Pollonera. Similar to the preceding [*muscorum* Drap.], but a little shorter; whorls 5½ to 6; aperture with a deeply placed, drop-shaped palatal tooth.

Italy: V. Dora Riparia, collina di Rivoli, in the alpine region of Piedmont.

V.[*ertigo*] (*Ist*[*hmia*]) *monodonta* Pollonera, Atti della R. Accad. delle Scienze di Torino, xx, 1885, p. 685.

Vertigo dinii De Stefani. Shell minute, with a small umbilicus, cylindric, pellucid, thin, tawny, a little convex, more inflated in the middle, slightly tapering above and below, longitudinally closely striate, the striæ oblique, visible under a lens, well raised; apex rather obtuse. Whorls 6½, the first 1½ small, the rest nearly equal, the last a little tapering, somewhat larger, rather convex, slowly ascending to the aperture. Aperture rounded, subtetragonal below, frequently 3-toothed: one very long tooth in the upper lip, sometimes 2, of which the upper is very short; in the columellar lip one, and one in the palate [i. e., the parietal wall]; peristome simple, a little expanded, interrupted above. Length 1.5, width 0.5 (*De Stefani*, Bull. Soc. Malac. Italiana, ix, 1883, p. 143).

Appenines: Sassorosso.

De Stefani further remarks that it may be a variety of *V. callicratis* Scacchi, but the very small size, the somewhat barrel-like form, the last whorl being more compressed than the others, and the teeth, which appear to be more numerous in some cases, retain it sufficiently distinct.

Truncatellina callicratis (Scacchi). Shell small, cylindric, corneous, umbilicate; whorls 5, rounded, obliquely striate; aperture ovate, toothless; lip a little reflected. Length scarcely 1, diam. ½ line (*Scacchi*).

Italy: Naples (type loc.); Sicily.

Turbo callicratis Scacchi, Osserv. Zool., 1833, p. 11.—*Pupa callicratis* Sc., Cat. Conch. Reg. Nap., p. 16.—Philippi, Enum. Moll. Sicil., ii, p. 220.—Pfr., Monogr., ii, p. 307.—*Pupa strobeli* var. *callicratis* Sc., Westerlund, Fauna, iii, 1877, p. 126. —*Vertigo callicratis* De Stefani, Bull. Soc. Malac. Ital., ix, 1883, p. 182, with var. *nodosaria,* and subvarieties *maruccii* and *simii.*

Westerlund, who obtained specimens from the original locality, states that *callicratis* is a form of *strobeli* [*rivierana*], differing from that by its still more cylindric form, rounded above, the more slowly increasing whorls which are therefore lower, more convex, the last built far forward in front; by the deeper suture and stronger sculpture (obliquely, finely ribbed on the upper half or throughout); the outer lip more strongly curved and expanded; the aperture as in typical *strobeli,* three-toothed, two-toothed or more rarely toothless.

The descriptions of the following forms are taken from Westerlund, as I have not seen De Stefani's paper.

Var. *nodosaria* De Stef. Whorls more convex; suture more deeply constricted; peristome more expanded, more strongly white-lipped; length 2, diam. 0.9 mm.

Subvar. *maruccii* De Stef. More lengthened, with less convex whorls; somewhat larger than typical *nodosaria.* Subvar. *simii* De Stef. Smaller, more compact and convex, aperture toothless; length 1.5, diam. 0.4 mm.

T. callicratis has not been figured. It was described before *rivierana,* and if Westerlund is right in thinking them forms of one species, the latter would take varietal rank. Yet until there can be a revision of the Swiss forms also, any rearrangement of the nomenclature would be futile.

Pupa muscorum var. *abanensis* De Gregorio (pl. 11, fig. 9). Shell most minute, pupiform, yellowish, subcylindric; whorls 4, convex, slowly increasing, penult scarcely wider than the last. Aperture erect, slightly margined; outer lip compressed in the middle; columellar lip with one fold. Length 2 mm.

Italy: Abano, in mud of ponds from the thermal springs.

Pupa muscorum L. var. *abanensis* De Greg., Ann. de Geol. et Pal., 32 livr., 1907, p. 7, pl. 1, f. 16.

"*P. muscorum*" is understood in the sense of Draparnaud. According to De Gregorio it differs from *Vert. dinii* De Stef. by the less cylindric shape and the compressed outer lip. Probably Recent or Pleistocene.

Var. *ortonensis* De Greg. (pl. 11, fig. 8). "Among the species from Monte Ortone [mud from thermal springs] I have one example which appears identical, but it has the outer lip provided with two teeth, the anterior lip with another tooth and one columellar tooth" (*Pupa muscorum* var. *ortonensis De Gregorio,* op. cit., pp. 7, 16, pl. 1, f. 29).

Scarcely a *Truncatellina,* if the description of teeth is correct; possibly a *Vertigo;* yet what can be done with such drivel as this paper? One hesitates between amusement and pity.

Pupa battagliensis De Greg. (pl. 11, fig. 7). Shell very minute, subcylindric, elegant, slowly increasing, ornamented with filiform riblets of growth, a little umbilicate. Whorls slowly increasing, convex; aperture subquadrangular, rounded, narrow. Length, 1 mm. A very rare species of which I have but one example. It appears to be of the type of *P. uva* L. (*De Gregorio*).

Italy: Battaglia, in mud from reservoir fed by hot springs (72° to 90° Centigrade).

Pupa battagliensis De Greg., Ann. de Geologie et de Paléontologie, 32 livr., 1907, p. 13, pl. 1, f. 30.

11. Truncatellina rivierana brittanica n. subsp. Pl. 8, figs. 13, 14.

The minute shell is shortly, deeply rimate, imperforate, cylindric in the last three whorls, those above forming an obtuse dome; cinnamon colored; glossy; evenly but not sharply rib-striate, the riblets oblique, about 2 in 0.1 mm. on the last whorl; first 1½ whorls smoothish, pale. The whorls are strongly convex, the last not flattened laterally towards the base, without any trace of a crest behind the lip. The aperture is ovate. Peristome paler than the shell, well thickened, but narrowly expanded. On the parietal wall there is a short tooth, so deep within that it is not seen in a direct face view. The columella has a strong but obtuse tooth, visible in an oblique view in the aperture. In the palate an immersed, rounded or oblong tubercle, visible in a direct front view.

Length 1.74, diam. 0.85 mm.; 5½ whorls. Type.

Length 1.65, diam. 0.83 mm.; nearly 5½ whorls.

England: Portland, Dorset, with *T. cylindrica* (G. C. Spence); type and paratypes no. 109423 A. N. S. P.

It resembles *T. rivierana* of southern Europe, but in that species the parietal lamella and the palatal fold are longer and stronger and the striæ more spaced. *T. odontostoma* is, according to Westerlund, a larger and relatively *longer* shell, 2⅓ mm. long, ¾ mm. wide, with 6-7 whorls and a thin peristome. If Westerlund's account is correct, the position of the palatal fold is different. Unfortunately, Westerlund's form has not been figured, and no other author has reviewed its characters and dimensions.

While it appears unlikely that this British form is without a name, I cannot find any applicable to it. By formally describing the shell, the attention of British conchologists will be called to it, and a more thorough investigation can be made than is possible from this side of the Atlantic. Various early Swiss species might be compared if anybody could tell what their characters are.

12. TRUNCATELLINA ODONTOSTOMA (Westerlund).

Shell cylindric, closely and regularly *striate, horn-yellow,* obtuse. Whorls 6, convex, the last somewhat larger, ascending in front, *almost without a crest* near the aperture. Aperture semi-oval, with one punctiform tooth deep within on the parietal wall and one drop-shaped tooth high up in the palate, *near the suture and rather far from the outer lip.* Peristome *thin.* Columellar margin expanded and reflected. Length 2⅓, diam. ¾ mm. (*West.*).

Norway: near Christiania, on the Aakershuus farm.

Pupa minutissima Hartm., [var.] *g, odontostoma* WESTERLUND, Malak. Bl., xxii, 1875, p. 132; Fauna Europæa, 1876, p. 191; Fauna Pal. Reg. etc., iii, 1887, p. 128. — BOETTGER, Nachrbl., 1879, p. 66. — *Pupa (Isthmia) odontostoma* WEST., Jahrb. d. Mal. Ges., x, 1883, p. 61. — *Isthmia odontostoma* WEST., Syn. Moll. extramar. Reg. Pal., 1897, p. 112.

The position of the palatal tubercle as described by Westerlund appears abnormal; yet he seems to have had more than one specimen, as the number of whorls is given as 6-7 in his latest description. He places the species among those in which the palatal tooth is *not visible* in a direct front view. In Malak. Blätter, xxii, p. 126, Westerlund says "Tirolia, Norvegia," but in later notices he ignores the former locality.

Boettger (1878) states that it is widely distributed in France; it has a little punctiform parietal tooth near the opening, and a palatal tooth placed as in *strobeli.* He considers it, apparently, a variety of *minutissima* [*cylindrica*]; but whether he actually had Westerlund's shell remains doubtful. Perhaps he had the form herein described as *T. brittanica.*

13. TRUNCATELLINA COSTULATA (Nilsson). Pl. 8, figs. 17, 18.

The shell is rimate, cylindric with very short obtuse summit, regularly finely costulate, chamois-colored, glossy. The whorls are strongly convex, the last rapidly tapering towards the base, having a *massive, whitish crest* behind the lip. Suture impressed, rising to the lip. Aperture broadly ovate or squarish. Parietal lamella long, entering deeply. Columellar

lamella immersed, low and wide. Palatal fold strong, immersed, dorsal, not visible in a front view. Peristome expanded, thickened within with a *heavy, wide white callus.*

Length 1.95, diam. 1 mm.; 6¼ whorls.

Length 1.85, diam. 0.9 mm.; 6¼ whorls.

Sweden, Denmark, northern Germany. Transcaucasus, Talysch region (Westerlund).

Pupa costulata Nilsson, Hist. Molluscorum Sveciae, 1822, p. 51 (Esperöd, Scaniae, in sylvis, inter folia putrida, humida). — Kuester, Conchyl. Cab., p. 101, pl. 13, f. 29, 30.—Pfr., Monogr., ii, 313; Malak. Bl., xxiii, 1876, p. 211 (nomenclature).—Westerlund, Fauna Moll. terr. fluv. Sveciæ, Norvegiæ et Daniæ, 1873, p. 246; Fauna, iii, 1887, p. 127, with var. allogyra, p. 128.—*Vertigo costulata* Nilss., Westerlund, Malak. Bl., xiv, 1867, p. 201 (Oeland, very abundant).—*Pupa (Isthmia) costulata* Nilss., Boettger, Jahrb. d. M. Ges., vi, p. 405; Bericht Senck. Ges., 1889, p. 25 (Caucasus). — *Isthmia costulata* Nilss., Steenberg, Danmarks Fauna, Landsnegle, 1911, p. 170, f. 140.

Pupa ascaniensis A. Schmidt, Zeitsch. f. Malak., 1849, p. 141 (Ascherleben and Halberstadt).—Kuester, Conchyl. Cab., p. 179, pl. 21, f. 15, 16.—Pfr., Monogr., iii, 554.

This species is easily recognized by the wide, rounded, light-colored crest behind the lip and the heavy white lip-callus within.

Var. allogyra West. Smaller, wider above; only 5 strongly convex whorls, cylindric with very deep suture, the last scarcely ascending, but little wider than the preceding, towards the back slowly, arcuately tapering; peristome strongly expanding, with a very thick lip within. Germany: Alt-Geltow near Potsdam, Jetschin (Westerlund).

14. Truncatellina claustralis (Gredler). Pl. 11, figs. 1, 2.

The shell is subperforate, cylindric or fusiform-cylindroid, obtuse, regularly and closely costulate-striate, silky, pellucid, flesh-colored. Whorls 6 to 6½, convex, the last tapering towards the aperture. Aperture narrow, semioval, biplicate: a distinct parietal fold, the other palatal, lamelliform, deeply

immersed, the columella with a tooth-like callus. Peristome simple, a little expanded, margins separated. Length ⅗ to ¾, width scarcely ¼ line [about l. 1.25 to 1.56, d. 0.5 mm.] (*Gredler*).

Var. *anodus*. Without tooth; occurs with the typical form (Gredler).

Southern Europe, from France to Dalmatia; originally found in the Austrian Tyrol near Salegg at the foot of the Schlern and gorge of the Sarn valley.

Pupa claustralis Gredler, Verh. zool.-bot. Vereins in Wien, vi, 1856, p. 116, pl. 2, f. 1.—Pfr., Monogr., iv, 678.—Westerlund, Malak. Bl., xxii, p. 126; Fauna, 1887, p. 127.—Boettger, Nachrbl., xi, 1879, p. 67 (distribution in France, etc.).—*Pupa (Isthmia) claustralis* Kobelt, Iconographie, (2), viii, p. 84, pl. 234, f. 1515. — Weiss, Nbl. d. Mal. Ges., 1894, p. 156 (Pleistocene, Weimar-Taubach).

Distinguished by the strong teeth, the palatal fold deeply immersed, concealed behind the columella in a direct face view. Variable in size among the specimens at hand.

Length 1.7, diam. 0.8 mm.

Length 1.55 mm.

Boettger considers *P. clavella* Reinh. scarcely varietally distinct from *claustralis* Gredl.; the supposed difference of contour noted by Reinhardt is not distinctive. *P. opisthodon* Reinh., too, Boettger held, is at most not more than varietally distinct, and cannot possibly be distinguished specifically by the stronger columellar tooth. Like *strobeli* and "*minutissima*," *P. claustralis* has a certain variability with locality, and as in most small Pupæ, a very wide distribution (Jahrb. d. Mal. Ges., x, 184).

14*a*. *T. claustralis salurnensis* (Reinh). Pl. 11, figs. 6*a-d*.

Shell dextral, minute, fusiform, subperforate, glossy, corneous, under the lens slightly striate. Whorls 6½, convex, the first rapidly increasing, third and fourth subequal, the rest slowly decreasing; last whorl tapering, slightly ascending in front; suture deep. Aperture rounded, vertical, 3-plicate: an entering lamelliform parietal fold, another strong one

deep on the columella. The third in the palate, deeply immersed. Peristome a little expanded, white-bordered. Length 1.5 to 1.6, width 0.5 to 0.6 mm.

Salurn, in the southern Tyrol, living under bushes and stones in company with *P. claustralis* and *P. strobeli* (Reinhardt).

Pupa (Isthmia) salurnensis REINHARDT, Jahrb. d. Mal. Ges., iv, 1877, p. 84, pl. 3, f. 7.—KOBELT, Iconographie (2), viii, p. 85, pl. 234, f. 1517.—*Pupa gredleri* Reinh., *olim*, on labels.

The surface is smooth and glossy; only in favorable light under the lens oblique striæ may be seen, never ribs; on the last part of the last whorl there are a few stronger wrinkles.

14*b*. *T. claustralis opisthodon* (Reinh.). Pl. 11, figs. 3, 4.

The shell differs from *claustralis* by being more ventricose in the middle, the finer rib-striation, stronger dentition (the columellar tooth especially being very strongly developed), and most notably by the very deep situation of the palatal tooth, which is not visible in an oblique view in the mouth, but always remains concealed behind the columellar tooth (*Reinhardt*).

Herculesbade, in southeastern Banat (Reinhardt).

P.[*upa*] *opisthodon* REINH., Sitz.-Ber. Ges. naturf. Freunde zu Berlin, 1879, p. 138. — KOBELT, Iconographie (2), viii, p. 85, pl. 234, f. 1518.

14*c*. *C. claustralis corcyrensis* (Boettger).

Shell generally larger, more cylindric, the apex more distinctly conic; whorls 7, costulate-striate, the striæ closer. Greatest diameter is in the middle (not in the upper part of the shell); otherwise very similar to the type. Length 1⅞ to 2, diam. ⅗ to ⅞ mm. (*Bttg.*).

Corfu. Rather scarce, sieved from moss.

Pupa (Isthmia) claustralis Gredl. var. *corcyrensis* BTTG., Jahrb. d. Mal. Ges., x, 1883, p. 318.

14*d*. *T. claustralis clavella* (Reinh.). Pl. 11, figs. 5*a-d*.

Shell club-shaped, the third whorl widest; with stronger, more spaced riblets, pale corneous. Aperture higher than

wide, the lip sharp, not at all reflected. Palatal fold very deep, a full half whorl within. Length 1½, diam. ⅔ mm.; 6½ convex whorls.

Caucasus: Borshom on the upper Kura (Schneider); Psirsk monastery (Leder).

Vertigo (Isthmia) clavella REINHARDT, Jahrb. d. M. Ges., iii, 1876, p. 368. — *P.[upa] clavella* REINHARDT, Jahrb., iv, 1877, p. 82, pl. 3, f. 6. — *Pupa (Isthmia) clavella* Reinh., BOETTGER, Jahrb., vi, 405.—KOBELT, Iconographie (2), viii, p. 84, pl. 234, f. 1516. — *Pupa (Isthmia) claustralis* Gredl. var. *clavella* Reinh., BTTG., Jahrb., x, p. 184.

The figures and description are from Reinhardt.

15. TRUNCATELLINA MONODON (Held). Pl. 8, figs. 15, 16, 19, 20.

Shell cylindric, obtuse, dextral, smoothish, rather glossy, brown. Aperture semi-ovate; peristome reflected, the lateral margin somewhat depressed; parietal wall 1-plicate. Whorls 6. Length 1, width scarcely ½ line (*Held*).

Shell cylindric with obtuse summit, rather regularly and finely striate, the last whorl almost ribbed, *reddish-brown*. Whorls 6, the upper convex, the last twice as wide as the penult, tapering downwards, strongly ascending in front, impressed on the neck. Aperture narrow, semi-ovate or almost rounded-triangular, with a curved, lamelliform parietal tooth, entering deeply, one tooth in the palate, oval, very strong and very deep within. Peristome expanded, reflected, thickened lip-like; outer margin *somewhat impressed, bay-like*. Length 2.25, diam. 0.8 mm. (*Westerlund*).

Southern Bavaria; Tyrol; Carinthia.

Vertigo monodon HELD, Isis, 1837, p. 304 (Bavaria).— *Pupa monodon* Held, REINHARDT, Nachrbl. d. Mal. Ges., iii, 1871, p. 185.—KOBELT, Iconographie (2), viii, p. 85, pl. 234, f. 1519.

Pupa schrankii Roth, KUESTER, Ueber das Bestehen u. Wirken der naturf. Ges. zu Bamberg, 3ter Bericht, 1856, p. 77 (drift of the Isar, southern Bavaria).

Pupa striata GREDLER, Vert. zool.-bot. Ver. Wien, vi, 1856, p. 118, pl. 2, f. 2 (southern Tyrol, numerous localities, 800 up to 5000 ft.).—WESTERLUND, Fauna, iii, 1887, p. 128.

There is a thick columellar callus, visible on breaking the shell, or in a very oblique view in the mouth, but in the specimens seen, the palatal tubercle is too far in to be visible in the mouth. It is a larger, more distinctly striate shell than *T. salurnensis*. Two measure: length 2.22, diam. 0.95 mm., and length 1.95 mm.

Reinhardt has noted that it has no inferior tentacles. When creeping on a horizontal surface the shell is held upright, like a tower. The merely striate, not ribbed surface is characteristic. The palatal tubercle is at least a half whorl back, not visible from in front, but showing through externally as a light spot. It lives on limestone and dolomitic terrains. The name "monodon" is a misnomer; Held overlooked the deeply placed palatal tooth.

Pl. 8, figs. 15, 16, are copied from Gredler's illustrations of *P. striata*.

The original account of *Vertigo unidentata*, which may be identical, follows.

[*Vertigo*] *unidentata* Studer. Only once I found two specimens in the narrow gorge through which one enters the Gasternthal from Kandersteg, on a fragment of cliff. F. Biguet considers it identical with the *mousseron* (*Pupa minuta*, above), but it is once again as large and of darker color (*Studer*, Naturwiss. Anzeiger d. allgem. Schweizerischen Ges. f. gesamten Naturwiss., May 1, 1820, p. 89).

This long-lost species was noticed by Hartmann, Férussac and Charpentier, without further characterization. Finally O. Reinhardt (Nachrbl. d. Malak. Ges., 1916, p. 131) reviewed its history. He believes that *unidentata* is perhaps *T. monodon* Held, which lives on damp rock faces, while most other species of the genus are ground snails. *T. monodon* has not been reported from Switzerland, but its occurrence there would be no great extension of its known range.

16. Truncatellina uniarmata (Küster).

Shell subumbilicate, cylindric, densely costulate-striate, subopaque, corneous-yellow. Spire high, the apex broadly conic, truncate. Whorls 7, convex, slowly increasing, joined by a

deep suture, the last whorl a little compressed, rounded at base. Aperture semi-oval, the margins approximating, joined by a very thin callus; right margin obsoletely impressed in the middle, a little thickened; columellar margin expanded, reflected; palate with one tooth; columella a little convexly calloused. Length 2, diam. 0.75 mm. (*Kuester*).

Triest (Kuester).

Pupa uniarmata KUESTER, Ueber das Bestehen und Wirken Naturf. Ges. Bamberg, 3ter Bericht, 1856, p. 77 (Triest); Neunter Bericht naturf. Ges. Bamberg, 1870, p. 99.—WESTERLUND, Fauna, iii, 1887, p. 128.

Differs from *minutissima* [*cylindrica*] by the size, cylindric form, one whorl more, the palatal tooth; from *ascaniensis* Schmidt [*costulata*] by size, longer columella, etc. It is fully as high as *P. striata* Gredler [*T. monodon* Held], but much slimmer, sharply ribbed, quite cylindric, with strongly convex whorls (*Kuester*). Not seen by the author. It has not been figured.

III. JAPANESE (LOOCHOO) SPECIES.

17. TRUNCATELLINA INSULIVAGA (Pils. & Hir.). Pl. 9, figs. 26, 27.

The shell is minute, shortly rimate but imperforate, cylindric, the summit rounded, obtuse, between chamois and pinkish-buff, thin, somewhat translucent. Surface rather glossy, smooth except for weak growth-striæ in places. The whorls are strongly convex, the last tapering downwards somewhat, its latter half being a little flattened laterally. The deep suture ascends a little to the aperture. The aperture is shortly pear-shaped, slightly oblique, the peristome very little expanded except at the columellar margin, the outer lip straightened or slightly bent in. The columella has an obtuse, oblong tooth, rather deeply placed, but partially visible in a front view in the type lot (seen only in oblique view in the mouth in specimens from Kunchan). Very deep within, past the median line of the back, there is a short palatal tubercle, not visible in the aperture.

Length 1.70, diam. 0.75 mm.; 6½ whorls. Type.

Length 1.65, diam. 0.72 mm.; 6½ whorls.

Loochoo Islands: Yoronjima, Osumi; a variety at Hentona, Kunchan (Hirase). Type 67624 A. N. S. P.

Pupa insulivaga Pilsbry & Hirase, Proc. A. N. S. Phila., 1904, p. 631.

Like the Oligocene *T. splendidula* and a few Recent European and South African forms, this species lacks the rib-striation common to most of the genus. In all other respects it is a typical *Truncatellina*. The palatal tubercle cannot be seen in an oblique view in the aperture, being unusually far within, and as the shell is rather opaque in the type lot, it was at first overlooked.

It resembles *T. uniarmata* and various South African species in having columellar and palatal teeth, but no parietal lamella.

Yoron Island, though politically belonging to Osumi Province, lies near the northern end of Okinawa, and thus is one of the central Loochoos.

The specimens from Kunchan (northern Okinawa, the large island of the central Loochoos) are mainly a little smaller, some being quite short, the cylindric portion of only three whorls (fig. 27), though others have four subequal whorls as in the type lot. These specimens show the palatal tubercle as a light spot on the outside.

Length 1.65, diam. 0.7 mm.

Length 1.45, diam. 0.7 mm.; 6 whorls (fig. 27).

IV. Species of Northeast Africa (Abyssinia).

These forms seem about equally related to the *rivierana-claustralis* group of Europe and to the South African *T. perplexa*.

1. Palatal, columellar and parietal teeth present..... 2.
   No palatal tooth; columellar inconspicuous; length 1⅜ mm. *T. blanfordi*, no. 21.
2. Palatal fold partially visible in a direct front view; rather spaced riblets; 1.5 mm. long, 5-6 whorls. *T. lardea*, no. 18.
   Palatal fold visible only in an oblique view in the mouth; rib-striation close; length 1.6 to 1.75 mm..... 3.

3. Parietal lamella low; base tapering downward.
T. schilleri, no. 19.

Parietal lamella rather high; base less tapering.
T. similis, no. 20.

The following account is taken from Jickeli, who collected and described all of the Abyssinian species.

18. TRUNCATELLINA LARDEA (Jickeli). Pl. 9, figs. 6, 7, 8, 9.

The shell is perforate, cylindric, brown, with an oily luster, under the lens distantly, rather obliquely ribbed. Whorls 5-6, rather swollen, regularly increasing, parted by a deep suture, the last slightly ascending in front. Aperture slightly oblique, ovate, 3-plicate: a deeply entering lamelliform parietal fold, a strong, obtuse columellar fold, seen in its entirety only by rolling the shell to the left, and a strong, palatal tooth, not entirely visible in a front view. Peristome white, expanded, slightly reflected; margins scarcely converging, joined by a very thin callus. Length 1.5, diam. 1 mm., length and width of aperture 0.5 mm. (*Jickeli*).

Abyssinia: Province Hamaszen on Rora-Beit-Andu about 4200 ft., and Habab at the descent of Nakfa (Jickeli).

Pupa lardea JICKELI, Fauna Moll. N.-O. Afrika's, in Nova Acta Ac. Caes. Leop.-Carol. Germ. Nat. Cur., vol. 37, 1875, p. 124, pl. 5, f. 14.

"This species differs from the very closely related *P. strobeli* Grdl. by the more compact form, more widely spaced longitudinal ribs, which are stouter and stronger. The Abyssinian snail, moreover, has a wider umbilicus and more convex but lower whorls. The chief difference is in the armature of the aperture, in form and situation of the teeth.

"The denticle of the parietal wall is placed deep in the mouth and bluntly pointed in *strobeli,* but in our species emerges more, is higher and stronger, and penetrates inward as a fold.

"The columellar fold in our species is hardly visible in a straight front view of the mouth, but appears, when the shell is turned a little, as a very strong, blunted tooth, while in *strobeli* it is very well shown in a direct front view and projects much less strongly.

"The palatal fold is less deeply placed in the mouth and weaker in *P. strobeli.*

"In the width of the perforation *P. claustralis* agrees with *P. lardea* better than *strobeli,* but in *claustralis* the columellar and palatal folds are deeper in the mouth, especially the latter.

"*P. salonensis* [*salurensis*] Reinh. is at once separable by its finer longitudinal striation" (*Jickeli*).

19. TRUNCATELLINA SCHILLERI (Jickeli). Pl. 9, figs. 14 to 18.

The minute shell is narrowly perforate, cylindric, a little contracted towards the base, brown, with an oily luster, ornamented with moderately strong, close, oblique longitudinal ribs. The 6 convex whorls increase regularly and are parted by a rather deep suture; last whorl is somewhat compressed towards the base and rises a little in front. The aperture is hardly oblique, ovate, a little impressed on the right side, and three-folded: on the parietal wall, deep within, a denticle stands which is continued inward as a rather low fold. The slightly curved columella has a tubercular tooth, visible only by turning the shell; likewise the palatal tooth is only seen by turning the aperture. The peristome is white, thickened and slightly reflected, the terminations converging.

Length 1⅝, diam. 1, alt. apert. ⅝, width ½ mm. (*Jickeli*).

Abyssinia: Eujelal, Habab Mts., 7995 ft. (*Jickeli*).

Pupa schilleri JICKELI, Nova Acta, vol. 37, 1875, p. 125, pl. 5, f. 15.

"*P. schilleri* differs from the preceding species by the more contracted base, narrower umbilicus, closer and finer longitudinal ribbing, a weaker and more deeply placed parietal lamella; also the columellar fold stands deeper, and the palatal fold, which is visible in *P. lardea* in a direct front view, can only be seen in *P. schilleri* in a strongly oblique view in the mouth.

"It agrees with *P. strobeli* in the umbilicus and longitudinal striation more than with the preceding species, but differs by the positions of columellar and palatal teeth.

"From *P. salonensis* [*salurensis*] Reinh. it differs by the stronger ribbing" (*Jickeli*).

Jickeli considers it doubtfully distinct from *P. claustralis,* but the single specimen of *schilleri* is wider, not so evenly cylindric, darker colored; the parietal lamella of *claustralis* is shorter and terminates on a part of the parietal wall visible in the aperture, while in the African snail it penetrates deeper within.

20. TRUNCATELLINA SIMILIS (Jickeli). Pl. 9, figs. 1 to 5.

The minute shell is narrowly perforate, cylindric, brown, with an oily luster, under the lens showing oblique, moderately crowded longitudinal ribs. The 5½ convex whorls increase regularly and are separated by a rather deep suture, the last whorl is contracted but little towards the base, and rises slightly to the aperture. The aperture recedes towards the base, is ovate and three-toothed. On the parietal wall stands a strong, rather high fold, beginning rather deep within, and running far inward. On the columella a blunt, strong, tubercular tooth, entirely seen only by turning the shell. On the palatal wall, at the same level with the columellar tooth, there is a tubercular tooth, only seen by turning the shell, as in a direct front view it is covered by the visible part of the columellar tooth. Peristome is thickened, slightly reflected, the margins but little converging. Length 1.75, diam. 1 mm., aperture alt. and width ⅝ mm. (*Jickeli*).

Abyssinia: Habab country, at the descent of Nakfa, one example (Jickeli).

Pupa similis JICKELI, Nova Acta, vol. 37, 1875, p. 296, pl. 5, f. 16.

Jickeli at first thought this a form of *P. schilleri* but later distinguished it. The form of *P. schilleri* is more compact, relatively wider; the last whorl contracts towards the base, so that the outer margin of the peristome is not arcuate as in *similis,* but rather straight. *P. similis* is, moreover, rather less closely ribbed and the upper whorls not so smooth as in *schilleri.* Finally, *P. similis* has a strong, high parietal lamella, *P. schilleri* a very low one, hardly noticeable; the columellar tooth in *similis* is at least partly visible in a direct front view, but not at all visible in *P. schilleri.*

21. TRUNCATELLINA BLANFORDI (Jickeli). Pl. 9, figs. 10 to 13.

The minute shell is perforate, cylindric, somewhat contracted towards the base, brown, with an oily luster, and covered with close, somewhat oblique, longitudinal riblets, which are seen only under a lens, as in the two preceding species. The 6 convex whorls increase regularly and are separated by a rather deep suture; last whorl rises a little to the aperture in front and is lightly compressed at base. The aperture is scarcely oblique, ovate. Rather deep within there is a small, pointed denticle. The columella is lightly bowed; in the middle a hardly noticeable swelling, which may be regarded as the beginning of a tooth, is perceptible. The palate is entirely unarmed. The peristome is whitish, slightly thickened and reflected; the margins converge. Length 1⅜, diam. ⅞, aperture alt. ⅝, width ½ mm. (*Jickeli*).

Abyssinia: Habab, in the gorge of Asqaq, on Nakfa, 5664 ft., on rotten wood; also on the descent of Nakfa at the village Sykk (Jickeli) 7 specimens.

Pupa blanfordi JICKELI, Nova Acta, vol. 37, 1875, p. 127, pl. 5, f. 17.

In shape and striation it agrees with *P. schilleri,* in the umbilicus with *P. lardea;* otherwise it differs from both of these as well as from *P. strobeli, claustralis* and *salonensis* by the absence of palatal and columellar folds (*Jickeli*).

V. CENTRAL AFRICAN SPECIES.

Certain species supposed by Mr. Preston to belong to *Ennea* appear to be Truncatellinæ, so far as one can judge from the figures and poor descriptions. I have not seen the shells.

22. TRUNCATELLINA NAIVASHAENSIS (Preston). Pl. 9, fig. 21.

Shell minute, cylindrical, yellowish-white; whorls 7, the first 3 rapidly increasing; the last elongately strangulate behind the outer lip, sculptured with oblique, moderately distant riblets; suture impressed; columella vertically descending, outwardly expanded over the umbilical area; labrum slightly reflexed especially below; aperture somewhat irregularly triangular, edentulate. Alt. nearly 2, diam. 0.75 mm. (*Preston*).

British East Africa: Naivasha.

Ennea naivashaensis PRESTON, Revue Zoologique Africaine, i, 1911, p. 219, pl. 11, f. 3.—*Ennea naivashaensis* Preston var. *elgonensis* PRESTON, Proc. Zool. Soc., 1913, p. 211.

T. n. elgonensis (Preston). Shell even more cylindrical than the typical form, with more closely set and more pronounced transverse riblets, the aperture also, through not being contracted at the base, has a less triangular appearance. Alt. 1.75, diam. maj. 1 mm. (*Preston*).

Mt. Elgon, Uganda (C. W. Woodhouse).

23. TRUNCATELLINA MUTANDAENSIS (Preston). Pl. 9, figs. 19, 20.

Shell differing from *Ennea naivashaensis* Preston, from Naivasha, British East Africa, in its darker color, more cylindrical form, less convex and rather longer whorls, and in the broader and more basally rounded aperture. Alt. 2, diam. maj. 1 mm. (*Preston*).

S.-W. Uganda: between Lake Mutanda and Lake Kivu (Robin Kemp).

Ennea mutandaensis PRESTON, Proc. Zool. Soc. Lond., 1913, p. 211, pl. 34, f. 13, 13*a*.

VI. SOUTH AFRICAN SPECIES.

These species are closely related to those of Abyssinia and Europe, distinguished from them merely by specific details.

T. dysorata and *quantula* are not known to the writer by specimens, but all the others have a columellar lamella in form of an oblong, vertical tubercle, strong or low, and either visible from in front or more often dorsal in position, and hardly to be seen without breaking the shell. Whether *dysorata* and *quantula* are really without the columellar tooth, like the *cylindrica* group of Europe, is not known.

Most of the South African species are like *T. insulivaga* of the Loochoo Is. and *T. uniarmata* of Europe in lacking a parietal lamella. It is present in *T. perplexa* only.

Pupa haploa and *P. psychion* M. & P. are lost species, not included in the following key.

Key to South African Species.

1. Aperture having parietal, columellar and palatal teeth. *T. perplexa*, no. 24.
   No parietal lamella or tooth. ..... 2.
2. Surface nearly smooth or quite weakly ribbed. *T. sykesi*, no. 29.
   Surface very finely striate; no palatal tooth; 1.87 x 0.9 mm. *T. quantula*, no. 27.
   Surface subregular rib-striate. ..... 3.
3. Aperture with an immersed palatal tooth. ..... 4.
   No palatal tooth. ..... 5.
4. Length 1.3 to 1.6 mm., 5½ whorls. *T. pretoriensis*, no. 25.
   Length 1.85 to 2.4 mm., 6¾ to 8⅓ whorls. *T. iota livingstonensis*, no. 28*a*.
5. Length 2 mm. or more, 7½ whorls. .....*T. iota*, no. 28.
   Length 1.57 mm., 5½ whorls. .....*T. dysorata*, no. 26.

24. TRUNCATELLINA PERPLEXA (Burnup). Pl. 9, figs. 24, 25.

Shell very small, umbilicate, cylindrical, thin, translucent, shining; pale brown; spire cylindrical, rounded above; sutures impressed; apex obtuse; whorls 6, very convex, closely transversely lirate, except the first two which are smooth; the shell at the fourth, fifth, and sixth whorls of nearly equal width, the last half-whorl acquiring its greatest expansion a little below the suture and then being flattened beneath, forming an infrasutural angle, the last whorl compressed towards the umbilicus. Aperture rounded, nearly ⅓ the height of the shell; peristome whitish, reflexed, especially at the columellar margin, thickened, the ends converging and connected by a thin callus; labrum [outer lip] slightly incurved about the middle; columella straight. The processes of the aperture consist of a small white parietal plait running inwards and there becoming strong, a stout white post-columellar plait, also running inwards, and a profoundly post-labral [palatal] tooth or plait hidden by the columella (*Burnup*).

Fig. 24. Type: height 1.72, width 0.82 mm.

Fig. 25. (sectional): height 1.80, width 0.77 mm. (*Burnup*).

Cape of Good Hope: Cradock; Port Elizabeth (Farquhar).

Transvaal: Johannesburg (McBean); Pretoria (Ponsonby coll.); Potchefstroom (Miss Livingston); Heidelberg (Connolly). Orange Free State: Bloemfontein (Connolly).

Pupa perplexa BURNUP, in Melvill & Ponsonby, Ann. Mag. N. H. (8), i, Jan. 1908, p. 80, pl. 1, f. 17, 18; Ann. Mag. (8), vii, 408. — *Jaminia perplexa* (Burnup), CONNOLLY, Ann. S. Afr. Mus., xi, 1912, p. 183.

Cradock may be selected as type locality. The long, strong parietal lamella and strong though immersed (dorsal or subdorsal) columellar lamella, distinguish it from all other known South African species.

"Twenty-four out of twenty-six specimens measured by me show very little variation in dimensions, the remaining two, both apparently mature, being somewhat more divergent, viz.:

Largest, height 1.88, width 0.83 mm.

Smallest, height 1.50, width 0.77 mm.

"Judging by the descriptions and figures alone, for I have not seen Jickeli's species, this shell must be akin to his *P. lardea, schilleri,* and *similis* from Upper Nubia, whose apertural processes seem arranged much on the same plan, its nearest ally being the last named; *similis* is, however, about one-fourth wider than the present species and has half a whorl less, while the peristome is less expanded and the labrum less bowed inwards and there is no callus. *P. lardea* and *schilleri* are more divergent, being not so high as *similis* and broader in proportion (*Burnup*).

Among European species, *perplexa* is most like *T. claustralis.*

25. TRUNCATELLINA PRETORIENSIS (Melv. & Pons.). Pl. 10, figs. 1, 2, 3.

"Shell very minute, thin, ashy-brown, the apex flattened, contabulate; whorls 5, very ventricose, delicately longitudinally striate throughout, the last three of equal width; aperture round; peristome a little thickened, simple, reflexed at the columellar margin. Length 1, width .55 mm. (*M. & P., pretoriensis*).

"Shell minute, rimate, subcylindrical, elliptical, thin, translucent, shining, very pale brown; spire elongate-turbinate,

with greatest width at the fourth whorl; sutures rather deeply impressed, apex very obtuse; whorls 5½, very convex, closely transversely striate, excepting the first 1½, which are smooth, the last compressed round the umbilical region. Aperture nearly erect, rounded, nearly ⅓ the height of the shell. Peristome slightly thickened and reflexed, more so at the columellar margin, scarcely paler than the rest of the shell, with labrum [outer lip] slightly straightened about the middle and much receding towards the base. Columella arcuate. The only tooth conspicuous, white, rounded, and remote, is situate inside, about midway between the last suture and the base, and about half a turn from the labrum [or outer lip].

"Height 1.47, width 0.79 mm.

"Height 1.33, width 0.78 mm.

"Largest: height 1.51, width 0.80 mm.

"Smallest: height 1.32, width 0.75 mm." (*Burnup, intradentata*).

Transvaal: Pretoria, type loc., and District (Farquhar, Connolly).

Pupa pretoriensis Melvill & Ponsonby, Ann. Mag. N. H. (6), xi, Jan. 1893, p. 21, pl. 3, f. 8; (8), i, Jan. 1908, p. 81. —*Jaminia pretoriensis* (Melv. & Pons.), Connolly, Ann. S. Afr. Mus., xi, 1912, p. 183.—*Pupa dysorata* M. & P. var. *intradentata* Burnup, Melv. & Pons., Ann. Mag. N. H. (8), i, 1908, p. 73, pl. 1, f. 5, 6.—*Pupa intradentata* Burnup, Ann. Mag. (8), vii, 1911, p. 405.

"This is the smallest of the South-African group examined by me, and is of a paler color than most. As compared with *P. perplexa,* which seems to be its nearest ally, it is smaller, smoother, paler and less cylindrical, is only rimate instead of umbilicate, has the peristome less reflexed, and is destitute of the postcolumellar and parietal plaits. As compared with *dysorata* (of which *intradentata* appears in the *Survey* as a variety), it is smaller, more slender, paler, less cylindrical, more loosely coiled, with more ventricose whorls and deeper sutures, and is rimate instead of umbilicate; the aperture is smaller and rounder, receding more at the base, and is furnished with a tooth in the gullet, not found in *dysorata*" (*Burnup*).

The type of *P. pretoriensis* was reported to Mr. Burnup as smashed, so that no comparison of *intradentata* could be made with it; as nothing was said in the original description of a tooth, the two shells were naturally supposed to be different. After the publication of *intradentata,* Connolly found that enough remained of the type of *pretoriensis* to leave no doubt of its identity with *intradentata.*

The palatal tooth is often visible in a direct face view, as in the type and fig. 2; in other shells it is somewhat further in, not visible from in front, but seen by turning the shell as in fig. 1. There is also a *columellar tubercle,* rather small, dorsal in position (fig. 3), which has heretofore been overlooked, yet it is constantly present in the specimens at hand. It may be seen imperfectly in an obliquely basal view in the mouth. Two specimens figured measure:

Length 1.4, diam. 0.74 mm.; 5⅓ whorls.

Length 1.6 mm.; 5⅔ whorls.

26. TRUNCATELLINA DYSORATA (Melv. & Pons.). Pl. 10, fig. 4.

"Shell minute, umbilicate, shortly cylindrical, thin, shining, horn-colored; spire cylindrical, being almost equally wide at the third, fourth, and fifth whorls; sutures impressed, apex rounded; whorls about 5½, convex, deeply closely transversely striate, excepting the apical whorls, which are smooth, the last rounded below and compressed about the umbilicus; aperture erect, somewhat quadrate, rounded above and below, exceeding ⅓ the height of the shell. Peristome slightly thickened and expanded, widely so at the columellar margin (which in the type is longitudinally chipped), paler than the rest of the shell, with labrum [outer lip] slightly bent inwards about the middle and columella nearly straight. There are no apertural processes. Height 1.57, width 0.9 mm." (*Burnup*).

Cape of Good Hope: Griqualand East. Type in coll. E. R. Sykes.

Pupa dysorata MELVILL & PONSONBY, Ann. Mag. N. H. (6), xi, Jan. 1893, p. 20, pl. 3, f. 4; xii, 1893, p. 111. (8), i, 1908, p. 73, pl. 1, f. 4.—BURNUP, Ann. Mag. (8), vii, 1911, p. 403. —*Pupa dysorota* M. & P., STURANY, Cat. S.-A. Moll., Denk-

schr. k. Akad. Wissensch. Wien, lxvii, p. 71.—*Jaminia dysorata* (M. & P.), Connolly, Ann. S. Afr. Mus., ix, 1912, p. 180.

T. dysorata is a short, relatively broad, toothless species, as yet known by the type specimen only. This has been redescribed by Mr. Burnup, whose figure and description are copied. It is not worth while to reproduce the insufficient and inaccurate earlier description of the same specimen.

27. Truncatellina quantula (Melv. & Pons.). Pl. 10, fig. 5.

"Shell very minute, rimate, diaphanous, brown, cylinder-shaped, the apex obtuse; whorls 6, microscopically delicately lirate, strongly swollen, especially the three middle ones; aperture ovate-rounded; peristome simple, reflected. Length 2, width .85 mm." (*Melv. & Pons.*).

Length 1.87, width 4th, 5th and 6th whorls 0.84, 6th whorl to labrum 0.91 mm. (M. & P., cotype).

Cape of Good Hope: Port Elizabeth, south of Baakens River to Schoenmakers Kop (J. Crawford).

Pupa quantula Melvill & Ponsonby, Ann. Mag. N. H., (6), xi, 1893, p. 20, pl. 3, f. 5; (8), i, 1908, p. 81, pl. 2, f. 19. —Burnup, same, vii, 1911, p. 409.—*Jaminia quantula* (M. & P.), Connolly, Ann. S. Afr. Mus., ix, 1912, p. 183.

"Exceedingly minute, with simple mouth and remarkably swollen, ventricose whorls, especially the third, fourth and fifth, and cylindriform in shape. It is longitudinally striated, but so minutely as to be almost invisible even with a fairly strong lens" (*M. & P.*).

"Its nearest ally seems to be *P. dysorata* M. & P., which it strongly resembles in its remarkably cylindrical form, but from which it may easily be distinguished by its greater length, comparative narrowness, rounder aperture and much finer sculpture" (*Burnup*).

28. Truncatellina iota (Melv. & Pons.). Pl. 10, figs. 6, 7.

"Shell very small, rimate, subcylindrical, elongate, thin, translucent, shining, pale brown; spire slightly narrowing upwards, the greatest width being at the fifth and sixth whorls. Sutures impressed. Apex obtuse. Whorls 7½, very

convex, closely lirate transversely excepting the first 2½, which are smooth, the last whorl compressed round the umbilical region, and flattened near the middle of the labium [outer lip]. Aperture straight, subangularly rounded, about ¼ the height of the shell, peristome reflexed, widely so at the columellar margin, slightly thickened, pale, untoothed, with labium [outer lip] somewhat incurved about the middle. Columella straight.

"Alt. 2.17, lat. 0.92 mm. (maj.).

"Alt. 2.10, lat. 0.88 mm. (min.) (*Burnup*).

"A slender cylindrical form which seems to be quite distinct from all described species, though seemingly comparable with *P. quantula* M. & P., which is less tapering upwards, broader in comparison to its length, and fine in sculpture, and also with *P. pentheri* Stur., a more conical shell, with smoother sculpture, the whorls particularly ventricose, and shallower sutures" (*Burnup*).

The original type (from Pretoria) is slightly smaller in dimensions than those given above, and is not in very perfect condition (*Melv. & Pons.*).

Transvaal: Pretoria, type loc. (Farquhar, McBean); Heidelberg (Miss Livingston); Standers Kop (Connolly). Zululand: Dukuduku Forest (Toppin).

Pupa iota Melv. & Pons., Ann. Mag. N. H., (6), xiv, 1894, p. 93, pl. 1, f. 10; Burnup in M. & P., (8), i, 1908, p. 77, pl. 1, f. 11, with var. *livingstonæ* Burnup, p. 77, pl. 1, f. 12.—Burnup, Ann. Mag. (8), vii, 1911, p. 406, with var. *livingstonæ*, p. 407.—*Jaminia iota* and var. *livingstonæ* Connolly, Ann. S. Afr. Mus., ix, 1912, p. 182.

The ribbing is decidedly stronger than in *T. sykesi*, but it varies a good deal, from moderately close to more spaced, in both the typical form and mut. *livingstonæ*. The size also is quite variable in single lots, the largest individuals, it appears, being the toothed mutation.

There is a well-developed columellar lamella, oblong and vertical, dorsal in position, in the typical *iota*, as well as in *livingstonæ*, but in the former not so large.

The type of *iota* was said to measure 1.25 x .5 mm., with 7

whorls; the size-mark on Melvill and Ponsonby's plate is 2 mm. long. A specimen from Pretoria measures, length 2, diam. 0.8, length of aperture 0.52 mm.; 7½ whorls. No doubt the dimensions given by these authors are incorrect; certainly their description of the aperture could hardly be made more false and misleading. For this reason, Mr. Burnup's description has been quoted above.

28*a*. *T. iota* mut. *livingstonæ* (Burnup). Pl. 10, figs. 8, 9, 10.

Shell very similar to the typical form, 8-whorled, cylindrical, impressed at the sutures, somewhat coarsely longitudinally striate; aperture simple, with one internal tooth opposite to the mouth, very obscurely designated in some specimens, which are therefore intermediate between this variety and the type. Alt. 2.02, width 0.84 mm. (*Burnup*, in M. & P.).

Transvaal: Pretoria (Connolly); subsequently found at Standers Kop (Standerton) (Connolly).

Two topotypes from Burnup measure:

Length 2.4, diam. 0.9, length aperture 0.65 mm.; 8⅓ whorls.

Length 2.1, diam. 0.83 mm.; 7¼ whorls.

Length 1.85, diam. 0.80 mm.; 6¾ whorls.

The palatal tubercle is too far in to be seen, at least in its entirety, in the direct front aspect, but it comes into view when the shell is turned very little, being dorsal in position. There is a rather strong *columellar lamella*, also dorsal (fig. 10). Over 1½ whorls at the summit are smooth, or under the microscope, irregularly granulose.

29. TRUNCATELLINA SYKESI (Melv. & Pons.). Pl. 10, figs. 11, 14, 15, 16, 17.

Shell rimate, minute, cylindric, diaphanous, with obtuse apex; whorls 7 or 8, ventricose, closely longitudinally, finely costulate throughout; aperture ovate, peristome a little reflected, provided with 2 teeth, one parietal, the other basal, opposite and inconspicuous. (Subsequently Melvill and Ponsonby state that the teeth "are found not to have any real existence, the mouth of the type having been clogged with certain foreign particles"). Length 1.90, width .75 mm. (M. & P.).

Cape of Good Hope: Griqualand East, type loc. (Sykes coll.); Port Elizabeth (Reeve); Pirie (Godfrey); Grahamstown (Farquhar). Natal: Majuba (Connolly); Durban; Umbilo Road (*pentheri*, Penther); Edendale; Game Pass; Ntimbankulu (Burnup). Zululand: Dukuduku (*pentheri*, Toppin).

Pupa sykesii Melv. & Pons., Ann. Mag. N. H. (6), xi, 1893, p. 21, pl. 3, f. 6; xii, 1893, p. 111 (corrected description); (8), i, 1908, p. 81, pl. 2, f. 20 (with var. *inconspicua* Burnup, f. 21). — *Pupa pentheri* Sturany, Catal. Südafr. Land- und Süsswasser-Moll., p. 70, in Denkschr. k. Akad. Wien, lxvii, 1898, p. 606.

The second, emended, description of Melvill and Ponsonby is given above, and their second figure (pl. 10, fig. 11), drawn by Burnup. This does not show sculpture as strong as one would infer from the description; probably the latter is incorrect.

Specimens before me from Game Pass of the Upper Mooi River (Burnup) have no riblets, merely slight, irregular growth-striæ. The shape varies between that of *sykesi* and *inconspicua*. Two measure:

Length 2.02, diam. 0.75 mm.; 7¼ whorls (fig. 15).

Length 1.84, diam. 0.8 mm.; 6¾ whorls (fig. 14).

A set from Cradock (Farquhar) shows weak costulation, a little stronger on the upper post-embryonic whorls, or merely striation, some being almost as smooth as the preceding, and none strong as in the northern *T. iota*.

Length 2.17, diam. 0.84 mm.; 7½ whorls (fig. 17).

Length 1.73, diam. 0.7 mm.; 6⅔ whorls (fig. 16).

Pupa pentheri Sturany. Pl. 10, fig. 13. The shell consists of about 7½ very regularly convex whorls, which are smooth and parted by a deeply-cut suture. The shape is conic, as it is wider at the base than above, and gradually tapers upwards. The apex is obtuse. Length 1.7, width 0.6 mm. Dr. Penther collected this minute species abundantly in Umbilo Road (*Sturany*).

29*a*. *T. sykesi inconspicua* (Burnup). Pl. 10, fig. 12.

"Shell very small, rimate, subcylindrical, elongate-oval,

very thin, subhyaline, shining, brown; spire slightly convexly narrowing upward above the fifth whorl, sutures impressed, apex obtuse; whorls 7½, convex, nearly smooth, faintly striate, with very fine microscopic, irregular transverse cuticles, becoming stronger towards the base, last whorl not much impressed around the umbilical region; aperture slightly oblique, rounded, nearly ¼ of the altitude of the shell; peristome reflexed, especially at the columellar margin, slightly thickened, connected by a thin callus, pale, untoothed, straightened near the middle of the labrum [outer margin]. Columella arcuate.

"Alt. 2.05, lat. 0.72 mm. (maj.).

"Alt. 1.94, lat. 0.77 mm. (min.)" (*Burnup*).

Dargle, Natal (Miss Livingston); Grahamstown, Cape Colony (Farquhar).

Pupa sykesi var. *inconspicua* BURNUP in Melvill & Ponsonby, Ann. Mag. (8), i, Jan. 1908, pp. 81, 82, pl. 1, f. 21.—BURNUP, Ann. Mag. (8), vii, 1911, p. 410.

"Although, while differentiating *inconspicua* from *sykesi* M. & P., from the material then at my disposal, I considered it to be a distinct species, I can now only concur with Melv. & Pons. in treating them as one. In coming to this decision I am largely indebted to Dr. R. Sturany, who not only identified for me specimens from Dukuduku Forest, Zululand, as being *P. pentheri* Stur., but also sent me co-types of his species collected by Dr. Penther at Umbilo Road, Durban. His specimens are somewhat intermediate between *sykesi* M. & P., and *inconspicua* Burnup, and leave no doubt as to all three forms belonging to one species. *P. pentheri* must, therefore, be placed in the synonymy of *sykesi,* and *inconspicua* may be retained as an elongate, narrow, fusiform variety of the same species.

"In adopting my description of the var. *inconspicua* in its entirety to represent their species, Melvill and Ponsonby are led into certain errors, in that their type is more conic and less fusiform than the var., and has only about 6¾ whorls instead of 7½, while the aperture is more than, instead of nearly, ¼ of the height of the shell; besides which the dimen-

sions given do not refer to the type, which measures: height 1.82, width 0.83.

"It may be noted that while the height of *inconspicua* is greater than that of the type, the width is less. As this attenuate form has so far only been met with at Dargle, it may well be a local race" (*Burnup*).

Dubious, lost species.

Pupa haploa Melvill & Ponsonby. Pl. 9, fig. 22. Shell oblong-pyramidal, very thin, apex blunted; whorls 7, ventricose, longitudinally finely striate throughout, impressed at the suture; aperture oval; peristome a little thickened, simple. Length 1.7, width .75 mm.

Pretoria. A very small oblong species, with simple and very slightly thickened peristome (*M. & P.*).

A small, simple-mouthed species, of which the type only occurred, unfortunately mislaid soon after description fifteen years ago. No example has since come to hand. Seemingly allied to *P. pretoriensis* M. & P. (*M. & P.*, 1908).

Pupa haploa M. & P., Ann. Mag. N. H. (6), xi, 1893, p. 21, pl. 3, f. 7; (8), i, 1908, p. 77. — *Jaminia haploa* (M. & P.), Connolly, Ann. S. Afr. Mus., xi, 1912, p. 284.

See note under the following species.

Pupa psichion Melvill & Ponsonby. Pl. 9, fig. 23. Shell umbilicate, rather obese, minute, pale brown, apex obtuse; whorls 6, tumid, somewhat flattened; aperture rounded; peristome thickened, simple. Length 2.5, width 1.5 mm. Pretoria. A minute species, like *haploa* (M. & P.), but the whorls are more tumid and only 6 in number. Mouth round, peristome simple, toothless, and without plaits (*M. & P.*). Type "no longer in existence, having been accidentally broken" (*M. & P.*).

Pupa psichion M. & P., Ann. Mag. N. H. (6), xiv, 1894, p. 93, pl. 1, f. 8; (8), i, 1908, p. 81.—*Jaminia psichion* (M. & P.), Connolly, Ann. S. Afr. Mus., xi, 1912, p. 285.

The diameter assigned suggests *Pupilla*. Neither this nor the preceding species are known to Burnup. Connolly writes:

"It appears advisable to transfer both the foregoing to the list of doubtful species. *P. haploa* was founded on a single specimen, which can only be regarded as lost, since it has proved quite impossible to trace its whereabouts. In the case of *psichion*, the type, the only known specimen, is so hope-

lessly broken that it is quite impossible even to determine to what group of the genus it belonged. The original descriptions and figures of these minute forms are hardly in themselves sufficient, and the Pretoria District, whence they were recorded, has since been often carefully searched, and yielded only the species mentioned [above]. It is probable that, if ever the missing type of *haploa* or cotypes of *psichion* turn up, they will prove to be identical with some forms already named; meanwhile no useful purpose can be served by retaining them in the list of collectible varieties."

Genus ACMOPUPA Boettger.

Acmopupa Bttg., Jahrb. Nassau. Ver. Nat., xlii, 1889, p. 271. Monotype: *Bulimus subtilissimus* Al. Braun.

The shell is minute, perforate-rimate, elongately fusiform, thin, glossy, nearly smooth; apex rather obtuse. Whorls 4 to 5, a little convex, slowly increasing, the penult more flattened, the last whorl forming one-third the total length. Aperture oval, toothless, the margins converging, a little reflected, columellar margin somewhat concave (*Bttg.*).

The type *A. subtilissima* (pl. 5, fig. 11, after Sandberger) is a minute shell less than 2 mm. long, with only microscopic striæ. While not uncommon, it is local. According to Boettger, no trace of descent from older or relationship with younger or recent land shells is known. Jooss has noticed another species, still undescribed (Nachrbl. d. Mal. Ges., 44, 1912, p. 37).

Acmopupa subtilissima (Al. Br.). *Bulimus subtilissimus* Al. Braun, in Walchner's Geognosie, 2d ed., p. 1137.—*Pupa s.*, Sandberger, Vorwelt, p. 398, pl. 23, f. 13. Upper Oligocene Landschneckenkalk von Hochheim.

The figures of Wenz (Jahrb. Nassau. Ver. Nat., 1914, p. 93, pl. 5, f. 14) show a more obtuse summit than Sandberger's figures.

Genus NEGULUS Boettger.

Negulus Bttg., Jahrb. Nassauischen Vereins für Naturkunde, Jahrg. 42, 1889, p. 268; type by original designation *Pupa reinhardti* Jickeli.

"Shell perforate, either cylindric-ovate or oblong, pecu-

liarly striate or costulate; [very small: 2 to 2.5 mm. long]; apex obtuse. Whorls 4½ to 5½, convex, parted by a deep suture, the last ⅖ to ⅓ the length. Aperture rather large, oblong, higher than wide, *toothless;* peristome a little thickened, slightly expanded, the margins converging, columellar margin somewhat concave'' (*Boettger*).

Distribution: Africa; Tertiary of Europe.

Figured on plate 5, figs. 14 to 21. The whorls are higher, increasing more rapidly than in *Truncatellina,* the proportions being much as in the recent *Pupoides hordacea* (Gabb). Perhaps *Negulus* is related to *Nesopupa* as a toothless side line, comparable to *Pronesopupa.* As none of the Neguli are at hand, I have not been able to compare the groups directly.

Besides the type, Dr. Boettger included in this genus the recent P. abyssinica Reinh. and several Tertiary species.

NEGULUS REINHARDTI (Jickeli). Pl. 5, figs. 16, 17, 18.

The perforate shell is cylindric-ovate, of a darker or lighter brown color, and under the lens, covered with obliquely longitudinal riblets. The slightly tapering spire terminates in an obtuse apex. The 5 convex whorls increase regularly, and are separated by a deep suture. The last whorl, which ascends hardly noticeably in front, forms nearly one-third of the total length of the shell; it tapers to the base, and appears slightly and bluntly angular under the suture above. The toothless aperture is oblique, receding towards the base, is elongate-rounded, and has straight, thickened margins, scarcely expanded; the columellar margin lightly curved, slightly reflected at the insertion, showing no callous thickening. The right margin of lip is slightly impressed from outward (*Jickeli*).

Length 2.6, diam. 1.25, alt. apert. 1⅙ mm.

Length 2.33, diam. 1⅙, alt. apert. ⅞ mm.

Abyssinia: Province Hamaszen at Mekerka, on moss-covered cliffs on the banks of the Toquor (Jickeli).

Pupa reinhardti JICKELI, Fauna der Land- und Süsswasser-Mollusken Nord-ost-Afrika's, in Nova Acta K. Leop.-Carol. Deutsch. Akad. Naturf., xxxvii, 1874, p. 122, pl. 5, f. 12.

It is distinguished from *P. abyssinica* by the less cylindric shape, wider umbilicus, more convex and regularly increasing whorls, of which the last scarcely (but in *abyssinica* strongly) ascends in front. It differs further by the longitudinal ribbing, darker color, the silky luster and unarmed aperture. From *P. edentula* it differs likewise by the longitudinal ribbing and silky gloss, also by the strong taper towards the base, larger last whorl, and the impressed outer lip (*Jickeli*).

NEGULUS ABYSSINICUS (Reinhardt). Pl. 5, figs. 19, 20, 21.

Shell small, perforate, cylindric-ovate, corneous, glossy, striatulate; suture moderate; whorls 5½, the first three rapidly, the following but little increasing, last a little prominent. Aperture higher than wide, toothless, rather oblique; peristome acute, slightly expanded, the columella thickened towards the parietal wall.

Length 2⅛, diam. 1, apert. ⅔ x ½ mm. (*Reinh.*).

Southern Abyssinia (Heuglin and Steudner).

Pupa edentula var. *minor* MARTENS, Malak. Blätter, 1866, p. 96.—*Pupa abyssinica* REINHARDT in von Martens, Mollusken, in v. d. Decken's Reisen in Ost-Afrika, iii, 1869, p. 151. —JICKELI, Moll. N.-O.-Afrika's, 1874, p. 123, pl. 5, f. 13.— *Pupa abessynica* Reinh., BOETTGER, Jahrb. Nassau. Vereins f. Naturk. Jahrg. 42, 1889, p. 269.

It differs from *P. edentula* by the more slender shape, narrower umbilicus, blunted apex and relatively higher whorls; further, the last whorl of *abyssinica* is higher, tapers more towards the base, and ascends somewhat in front. The aperture in *abyssinica* is higher than wide, the right margin lightly impressed and the columella distinguished by a tooth-like swelling at the insertion. In *P. edentula* the aperture is as wide as high, the right margin beautifully arched, and the columella shows only a hardly noticeable thickening at the insertion (*Jickeli*).

NEGULUS KENIANUS (Preston). Pl. 5, fig. 14.

"Shell minute, cylindrically ovate with very obtuse apex, scarcely rimate, moderately thin, pale reddish-chestnut; whorls 4, convex, shouldered above, marked with fine, oblique,

transverse striæ and slightly malleated; suture well impressed; columella whitish, internally broad; labrum erectly reflexed, the margins joined by a thin whitish callus; aperture very broadly inversely auriform. Alt. 2, diam. maj. 2.25 mm." (*Preston*).

British East Africa: Mt. Kenia at from 6000 to 9000 ft. (Robin Kemp).

Alæa keniana PRESTON, Proc. Zool. Soc. Lond., 1912, p. 189, pl. 31, f. 6.

The diameter assigned by Preston is probably an error for 1.25 mm. The sculpture described reminds one of *Nesopupa corrugata*. Not seen by the writer.

NEGULUS OBLIQUICOSTULATUS (Smith). Pl. 5, fig. 15.

Shell minute, cylindric, pale brownish, rimate. Whorls 6, a little convex, separated by a deep suture, ornamented with arcuate, thin, very oblique riblets, the last slightly contracted in front, a little ascending, somewhat impressed behind the lip. Aperture rounded, subquadrate, about one-third the total length, scarcely toothed within; peristome thin, narrowly expanded throughout, the margins approaching above.

Length 2, diam. 0.75 mm.; aperture ⅔ mm. long, ½ wide (*Smith*).

St. Helena: Sugarloaf Quarry, extinct (Turton).

Pupa obliquicostulata E. A. SMITH, Proc. Zool. Soc. London, 1892, p. 268, pl. 22, f. 21.

"This is a very minute species, with very oblique, slender and somewhat remote costulæ and no teeth within the aperture (*Smith*).

Systematic place doubtful; it may be a *Truncatellina*, but the sculpture and proportions seem more like *Negulus*. Not seen by the writer.

European Tertiary Species.

NEGULUS SUTURALIS (Sandberger). *Pupa suturalis* Sandb., Conch. Mainzer. Tert.-Beckens, 1863, p. 54, pl. 5, f. 13; pl. 6, f. 1. — *Negulus suturalis* Fischer and Wenz, Jahrb. Nassau. Ver. Nat., 67 Jahrg., 1914, p. 92, pl. 5, f. 13.—*Pupa edentula*

Deshayes, An. s. Vert. Bassin Paris, ii, 1866, p. 850, pl. 56, f. 28-30.—*Bulimus lineolatus* Al. Braun, in Walchner's Geognosie, 2 edit., p. 1136.—*Pupa lineolata* Sandberger, Vorwelt, p. 397.—*Negulus lineolata* (Al. Br.), Boettger, Jahrb. Nassau. Ver. Nat., Jahrg. 42, 1889, p. 269—Jooss, Nachrbl., 1912, p. 36. Upper Oligocene and Lower Miocene, Bohemia, Germany and France.

K. Fischer and W. Wenz, in an excellent paper on the Landshell chalk of the Main Basin (1914), state that this is by far the commonest Vertiginid of Hochheim. They do not quote Al. Braun, adopting the later name of Sandberger.

Negulus lineolatus sublineolatus Boettger, op. cit., p. 270, pl. 6, f. 8. Upper Oligocene, Hochheim.

Negulus suturalis gracilis Gottschick & Wenz, Nachrbl. d. Malak. Ges., 1919, p. 9, pl. 1, f. 12, 13. Steinheim am Aalbruch. Also *N. suturalis francofurtanus,* p. 10.

Negulus raricosta (Slav.). *Pupa raricosta* Slavik Arch. f. naturwiss. Landesdurchf. v. Böhmen, i, 2, p. 266, pl. 4, f. 9-11. —*N. raricosta* Klika, Tert. Land- und Süsswasser-Conch. des n.-w. Böhmen, Archiv naturwiss. Landesdurchf. Böhmen, vii, no. 4, 1891, p. 91, f. 86. Tuchoric, Bohemia.

Negulus villafranchianus (Sacco). *Vertigo villafranchiana* Sacco, Bull. Soc. Mal. Ital., xi, 1885, p. 176; Mem. R. Accad. Torino (2), xxxix, 1888, p. 18, pl. 1, f. 3. Upper Pliocene, Tassarolo, near Novi, Piedmont. *Pupa (Isthmia) villafranchiana* Sacco, von Troll, Jahrb. K. K. Geol. Reichsanst., lvii, 1907, p. 75. "Heilsamer Brunnen" near Leobersdorf, Austria.

Negulus bleicheri (Paladilhe). *Vertigo bleicheri* Palad., Rev. Sci. Nat., ii, 1873, p. 51, Pliocene, Montpellier, is placed here by Gottschick and Wenz. It was included in Vol. XXV, p. 219, as a doubtful *Vertigo.*

Pupa crossei Mich., Journ. de Conchyl., x, 1862, p. 7, *Vertigo crossei* on pl. 4, f. 3. Pliocene, Hauterive (Drôme), noted in Vol. XXV, p. 220, may possibly be a *Negulus;* its place is not clear to me.

Pupa anodon Desh. (see Vol. XXV, p. 218) is another edentulous species of uncertain affinities.

PUPA PALANGULA Boissy, Mém. Soc. Géol. France (2), iii, 1848, p. 276; Deshayes, An. s. Vert. Bassin Paris, ii, 1864, p. 849, pl. 55, f. 25-27, from the lower lacustrine bed, Rilly, has also somewhat the aspect of *Negulus*.

Subfamily PUPILLINÆ.

This group is characterized by the possession of inferior tentacles. Prior to the adult stage the shell has no apertural armature. Adults have 0 to 5 teeth in the typical positions; angular lamella when present is tuberculiform (not entering and lamelliform, as in Gastrocoptinæ), and remote from the parietal lamella. Basal lamella is wanting. The peristome is usually reflected or expanded. The size of the shell is usually greater than in Vertigininæ, and the small teeth, when present, obstruct the aperture very little.

Distribution continental, with the exception of *Pupoidopsis* from Oahu, the relationships of which are uncertain.

Genus PUPOIDOPSIS Pilsbry & Cooke, n. gen.

The shell is umbilicate and openly rimate, conic-turrited, thin, of few (4 to 4½) very convex whorls. Aperture oblique, ovate, toothless; peristome slightly expanded and a little thickened within, the columellar margin dilated; margins converging, joined by a short parietal callus. Internal axis rather large.

Type: *P. hawaiensis*. Distribution: Lower zone of the Hawaiian Islands, in Post-Pliocene deposits.

These shells remind one forcibly of the continental genus *Pupoides;* but they differ by the decidedly larger internal axis (compare pl. 17, fig. 1, *Pupoides,* and fig. 2, *Pupoidopsis*), the distinct umbilicus, the less developed peristome and the absence of any trace of an angular lamella or tubercle. The genus is probably not directly related to *Pupoides;* we doubt whether it belongs to the Pupillinæ. Yet we are unable to suggest any more likely place, and the general appearance

would cause it to be looked for here. Young specimens are toothless like the adult stage.

PUPOIDOPSIS HAWAIENSIS Pils. & Cooke, n. sp. Pl. 17, fig. 2.

The shell is umbilicate and rimate, conic-turrited, thin, vinaceous-cinnamon to pinkish-buff or white (the specimens being fossil, and more or less faded); very weakly striate. The whorls are conspicuously inflated and increase rather rapidly, the first and especially the second being unusually large; the last whorl ascends slightly and slowly to the aperture, and is rounded around the somewhat funnel-shaped umbilicus. The aperture is somewhat oblique, ovate, without teeth, its length contained 2.4 to 2.8 times in that of the shell. The peristome is built forward nearly to the ventral convexity of the whorl; the margins converge and are connected by a very thin parietal callus; outer and basal margins are very slightly expanded, somewhat thickened within; columella concave, the columellar margin dilated.

Length 3.83, diam. 2.28, aperture 1.55 mm.; 4½ whorls.

Length 3.57, diam. 2.15, aperture 1.4 mm.; 4½ whorls.

Length 3.4, diam. 2.05, aperture 1.22 mm.; 4½ whorls.

Oahu: Kaelepulu, Kailua, on a low rock shelf, abundant (Pilsbry; type 129782 A. N. S. P., cotype in Bishop Mus.); Laie, west of stream, between the road and the sea, in a dune deposit, and on the calcareous sandstone bluff 1½ miles west of Kahuku (Cooke and Pilsbry). On the kona side of the main range on the coral plain below Ewa mill and Waimanalo (Cooke).

Molokai: Mauna Loa, northern slope, where the shifting sands cross, and Kaiehu, west of and near Moomomi (Cooke); Moomomi (Cooke and Pilsbry).

West Maui: Waihee (Cooke).

Some of the best-preserved shells are translucent enough to show the axis faintly through the last whorl.

It has been found only in Holocene and perhaps Pleistocene deposits, which also contain a multitude of other land shells, Pupillidæ, Tornatellinidæ, Amastridæ, Helicinidæ and others. Most of these deposits are from near sea level to a few hun-

dred feet above. It belonged to the lowland fauna, which has been almost wholly destroyed by deforestation since the discovery of the islands by Europeans.

The Laie specimens are rather small:

Length 3.7, diam. 2.1 mm.; 4½ whorls.

Length 3.2, diam. 2 mm.; 4 whorls.

Those from Molokai and West Maui offer no noticeable variation from the Oahuan shells.

Genus PUPOIDES Pfeiffer.

Pupoides Pfr., Malak. Blätter, i, 1854, p. 192, for *Bulimus nitidulus* Pfr. and *B. marginatus* Say.—Pilsbry and Vanatta, Proc. A. N. S. Phila., 1900, p. 585.—Kobelt, Syst. Conchylien-Cabinet, Buliminidæ, p. 917.—Iredale, Proc. Malac. Soc. Lond., xi, p. 176.—Gude, Fauna of British India, Moll., ii, 1914, p. 259, *P. nitidulus* Pfr. selected as type.

Leucochila v. Martens in Albers, Die Heliceen, 1860, p. 296, type by original designation *Pupa fallax* (=*P. marginatus* Say).

Leucochiloides Pfeiffer, Nomencl. Hel. Viv., 1878, p. 292. *B. lardeus* (Pfr.) designated as type by Connolly, Ann. S. Afr. Mus., xi, 1912, p. 176.

The shell is small (about 3 to 6 mm. long), rimate, long-ovate, turrited or rarely cylindric, with obtuse apex and few (generally 5-6) rather long whorls. Aperture ovate, toothless except for a small, tuberculiform, angular lamella close to the insertion of the outer lip, or united with it, rarely wanting; peristome expanded, reflected and usually thickened within. Internal axis slender, perforate (pl. 17, fig. 1).

Type: *P. nitidulus* (Pfr.). Distribution: all of the continents except Europe.

Pupoides differs from *Pupilla* by the tapering spire, the longer, more loosely coiled whorls, longer aperture and the obliquity of the parietal margin of the latter. There is never a crest or a furrow behind the lip. It is closely similar to the genus *Ena* (*Buliminus* of many authors); almost the only difference in the shells is that *Pupoides* is smaller. The genitalia in *P. marginatus* show close similarity to *Pupilla*, the

appendix being simple, rather short, and the spermathecal duct without a diverticulum. In *Ena* there is a very long appendix, coiled and enlarged distally, and a long branch of the spermathecal duct, with various other differences. This is one of several points where the Bulimini and Pupæ approach very closely. The separation of the former group as a distinct family appears to be without sufficient foundation.

A monograph has been published by Kobelt in his useful volume on "Buliminidæ," but the species were partly scattered among those of other genera and no revision or new information was attempted.

The American and Australian species are now fairly well understood. Many of those of Africa, Arabia and Mesopotamia were described by authors who made no comparisons with the older species; they may be in large part referable to *P. cœnopictus* as synonyms or local races.

Though many descriptions call these shells "umbilicate," they are properly designated *rimate;* sometimes with also a very minute perforation. The internal axis is quite slender, as in pl. 17, fig. 1, representing *Pupoides nitidulus.*

Pupoides is mainly a tropical and subtropical genus of arid regions or of relatively dry stations in humid areas. The American species harbor under stones or at the roots of grass; following rains they are sometimes found on trees a few feet from the ground. The living shells are often coated with dirt adhering by the slime of the animal.

As in *Pupilla,* the sinistral species belong to decidedly arid regions. They are found only in Central and West Australia.

The distribution of *Pupoides* is remarkably discontinuous. In Asia and Africa its range is about like that of *Zootecus,* which prefers similar climates. The absence of the genus in southeastern Asia and the East Indies leaves the Australian herd profoundly isolated, as is also the American herd. Yet the hypothesis of radiation from a northern, Asiatic or Asiatico-American center, as in the case of *Gastrocopta,* appears not improbable.

A species referable to *Pupoides* or perhaps *Microstele* has been described as *Pupoides pilsbryi* Dall (Monograph of the

Molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida, in Bull. 90, U. S. Nat. Mus., 1915, p. 29, pl. 1, f. 6) from Tampa Silex bed, Ballast Point, Tampa Bay, Florida. Though described as without teeth, the figure shows three.

I. American species, nos. 1 to 7.
II. Oriental and Ethiopian species, nos. 8 to 23.
III. Australian species, nos. 24 to 28.

I. American Species of Pupoides.

1. Shell distinctly tapering; diam. half the length, more or less. 2
   Shell cylindric or subcylindric; diam. decidedly less than half the length 5
2. An angular lamella represented by a small, callous pad joined to the outer lip 3
   Angular lamella a distinct and separate tubercle. *P. cœnopictus,* no. 10.
   No angular tubercle or pad; 3.4 to 4.2 mm. long, 4½ to 5 whorls. ..... *P. modicus,* no. 3.
3. About 5 mm. long; 5½ to 6 whorls; U. S., Mex., West Indies. ..... *P. marginatus,* no. 1.
   3.6 to 4.2 mm. long, 4¾ to 5 whorls. 4
4. West Indies. ..... *P. m. nitidulus,* no. 1*a*.
   Venezuela. ..... *P. simoni,* no. 2.
5. North American species. 6
   South American; cylindric, with slender riblets. *P. paredesii,* no. 7.
6. Cylindric; no angular tubercle or callous pad. 7
   Slowly tapering, slender, with a small angular tubercle; Mazatlan. ..... *P. chordatus,* no. 6.
7. With slender, spaced riblets; Arizona, New Mexico. *P. hordaceus,* no. 4.
   Nearly smooth; South Dakota to New Mexico. *P. inornatus,* no. 5.

1. PUPOIDES MARGINATUS (Say). Pl. 12, figs. 1 to 7.

The shell is minutely perforate, rimate, slowly tapering from the last whorl to the obtuse summit, cinnamon or slightly darker, paler behind the lip, somewhat glossy. Surface lightly marked with striæ of growth, wanting on the first whorl, which is weakly, microscopically granose. The whorls are rather strongly convex, the last half-whorl somewhat compressed laterally, tapering to the narrowly rounded base. The aperture is oval; peristome expanded and reflected, strongly *thickened within*, its face flattened; the outer lip is *more strongly arched near the upper insertion*, its internal callus excavated and narrower there. The columellar margin is straightened, dilated and reflected. Parietal callus rather strong but transparent, bearing a short angular tubercle connected with the outer lip.. Length 5, diam. 2.2 mm.; barely 6 whorls.

Eastern North America from Ontario and Maine to the Gulf of Mexico, west to the Dakotas, Colorado, and western Arizona (Yuma Co.); in northeastern Mexico at Monterey and Tampico. Cuba: El Vedado and Morro Castle, near Havana and around Cienfuegos (Pilsbry); Bahia Honda and Cabañas Light (J. B. Henderson). Haiti and Santo Domingo (Sallé, Gabb). Porto Rico (Riise). Bermuda.

Cyclostoma marginata SAY, Journ. A. N. S. Phila., ii, 1821, p. 172 (Upper Missouri).—*Bulimus marginatus* Say, BINNEY, Terr. Moll., iv, p. 136.—PFR., Mon. Hel. Viv., ii, p. 76.—WEINLAND, Jahrb. d. m. Ges., 1880, p. 376 (Jeremie and Port-au-Prince, Haiti).—*Pupa marginata* Say, MARTENS, Biologia Centr. Amer., Moll., p. 329, pl. 19, f. 1 (Mexico, "probably near the City"; also St. Croix). — *Pupoides marginatus* (Say), PILSBRY & VANATTA, Proc. A. N. S. Phila., 1900, p. 586.—WALKER, Occas. Papers Mus. Zool. Univ. Michigan, no. 15, 1915, pp. 2-10 (localities in Ariz., N. Mex., Texas, Okla.). —*Pupa fallax* Say, GOULD, Boston Journ. Nat. Hist., iv, p. 357, pl. 16, f. 15.—PFEIFFER, Mon. Hel. Viv., ii, p. 309.—BINNEY, Terr. Moll., v, 1878, p. 203, pl. 52, f. 1 (shell), pl. iv, f. T (teeth).—GIBBONS, Journ. of Conch., ii, 1879, p. 131 (Havana, Puerto Plata, Curacao, Cartagena, Puerto Cabello). — *Palu-*

dina turrita MENKE, Synops. Meth. Moll., 1830, p. 40; no locality or definition; *Cyclostoma marginatum* Say quoted as doubtfully the same. — *Pupa albilabris* (Ward MS.) C. B. ADAMS, Amer. Journ. of Sci., xl, 1841, p. 271 (substitute for *marginatus* Say); Thompson's Vermont, Moll., 1842, p. 158.— *Bulimus exiguus* REEVE, Conch. Icon., v, 1850, pl. 88, fig. 654 (St. Domingo, Sallé).—*Pupa arizonensis* GABB, Amer. Journ. of Conch., ii, 1866, p. 331, pl. 21, f. 6 (Fort Grant, Arizona).

The distribution is given above from specimens seen. Localities on the Spanish main are mentioned by Gibbons, but I have not confirmed them. Dr. Sterki has stated that Curacao specimens in the Mazyck collection are typical. In the United States it may be found in all the states from Arizona and Colorado eastward, but, so far as I know, nowhere at high elevations, either in the West or in the Alleghenies.

The size varies considerably in the same colony. Around Philadelphia (pl. 12, fig. 1) some lots run from 4.2 to 4.8 mm. long. In others the largest are 5 mm. long. It prefers places where the rock is limestone, though also common elsewhere. The living shell is usually more or less coated with earth or excrement.

Figs. 2, 3 represent shalls from Washington Co., South Dakota. The prominence of the angular tubercle varies, as in most Western lots.

In a lot from near Monterey, Nuevo Leon, Mexico, the size ranges from 4 mm. long, 5½ whorls, to 5 mm., 6 whorls.

In Arizona the shell is often small and delicate, length 4 mm., hardly over 5 whorls, with scarcely any callous pad in the angle of the mouth (pl. 12, fig. 4, Plumosa Range about 8 miles east of Quartzsite, western Arizona), thus resembling *P. modicus;* but in the same lots there are also larger shells.

The most slender examples are from the Gulf States (pl. 12, fig. 5, Big Wills Valley, Alabama), measuring, length 5, diam. 2 mm., 6½ whorls.

The West Indian shells (pl. 12, figs. 6, 7, Castillo de Jagua, entrance of Cienfuegos Bay, Cuba) are mainly typical in form, the angular callus strongly developed but in some lots there are also broader shells than any seen from the United States. Those figured measure:

Length 5.6, diam. 2.4 mm.; 6¼ whorls (fig. 6).

Length 4.8, diam. 2.55 mm.; 5½ whorls (fig. 7).

This broad form occurs in several lots from Cuba and Haiti; also in a lot from Tampico, the shells here being smaller.

The Bermudan form may be referable to *P. m. nitidulus;* it measures 4 to 4.5 mm. long. Specimens seen from Church Cave near Tucker's Town, Fairyland, near Hamilton and Port Royal (S. Brown), Flatts near Frascati Hotel (A. Gulick).

This shell has usually been known as *Pupa fallax* Say, but that species was based upon a stray example of *Ena obscura* (Müll.) of Europe. The same specimen, apparently, served for type of *Pupa placida* Say.

1*a*. P. MARGINATUS NITIDULUS (Pfr.). Pl. 12, figs. 9, 16.

The shell is smaller than typical *marginatus* with 5 to 5½ whorls; angular callus weak or scarcely noticeable. Peristome reflected and calloused within.

Length 3.6, diam. 2 mm.; 5 whorls. Matanzas.

Length 4.2, diam. 2 mm.; 5½ whorls. Matanzas.

Length 4.3, diam. 2.15 mm.; 5½ whorls. Matanzas.

Cuba: Havana, Matanzas and Trinidad (Pilsbry); Cabañas Light (Henderson). Jamaica: Kingston (C. W. Johnson and Wm. J. Fox). Haiti: Cape Hatien, Port-au-Prince, Charmettes, St. Mark (J. B. Henderson); Yuma (H. Prime); Santo Domingo (Gabb). Porto Rico: Ponce (Bland and others. St. Croix (Riise). St. Bartholomew (Dr. Cleve). Antigua (W. R. Forrest). Bahamas: Inagua (C. J. Maynard); Mangrove Cay, Andros (O. Bryant).

Bulimus nitidulus PFEIFFER, Wiegmann's Archiv f. Naturg., 1839, i, p. 352; Monogr. Hel. Viv., ii, p. 117; iii, 349; iv, 414; vi, 59 (exclusive of var. *B. exiguus*); in Kuester's Conchyl.-Cabinet, *Bulimus,* p. 153, pl. 39, f. 23-25.—*Bulimus nitidulus* Pfr., MAZE, Journ. de Conch., 1890, p. 26 (Philisbourg, Guadaloupe).— CROSSE, J. de C., 1890, p. 200 (Cuban localities, etc.); 1891, p. 127 (Santiago, S. Domingo); 1892, p. 22 (Fajardo, Pto. Rico).—*Pupa parraiana* ORBIGNY, Hist. Fis., Polit.

y Nat. de la Isla de Cuba, v, Moluscas, 1845, p. 96, pl. 12, f. 9, 11.

Topotypes are figured from a quarry near the road on the west side of Matanzas Bay, where it is abundant.

This is the common West Indian *Pupoides,* much more generally diffused than *P. marginatus.* It intergrades in size with *marginatus,* though the latter is rarely so small; yet the prevalence of this minor form indicates racial diversity which may properly be recognized in taxonomy. It is very much like *P. modicus,* but fully adult shells differ by the internally thickened lip of *nitidulus.*

The original descriptions follow.

Pupa parraiana. — Shell oblong-ovate, subcylindric-perforate, brown, smooth; spire lengthened, apex acuminate-obtuse; 6 convex whorls; aperture oval; lip margin wide, reflected, white. Length 4, diam. 1.5 mm. Cuba (*Orbigny*).

Bulimus nitidulus. — Shell rimate-perforate, oblong, solid, striatulate, somewhat glossy, tawny; suture deep; whorls 5½, convex, scalariform, the last about one-third the length. Aperture oval; peristome expanded white, somewhat lipped within, margins converging, the right margin arched, columellar somewhat straight, dilated. Length 4, diam. 2 mm., aperture 1½ mm. long, 1 wide. Very rare around Matanzas, Cuba (*Pfr.*).

2. PUPOIDES SIMONI (Jouss.). Pl. 12, fig. 8.

Shell rimate-perforate, ovate, thin, transparent, the pale corneous color is a yellow quite noticeably tinged with reddish. The spire is convexly conic, apex obtuse. Whorls 5½, irregularly coiled, the penult larger, giving the shell a ventricose aspect. Two earlier whorls smooth, the rest having fine, oblique striæ, nearly effaced, quite regularly placed, visible only under a strong lens. Aperture subovate, rounded, toothless; the peristome widely reflected, whitish with a red band around the throat, strongly curved in at the posterior insertion. Columellar margin straightened, reflected above the umbilicus. Parietal callus thin. Length nearly 4, diam. nearly 2 mm.

Venezuela: Caracas (Simon).

Leucochila simoni JOUSSEAUME, Mém. Soc. Zool. de France, ii, 1889, p. 246, pl. 9, f. 2.

About the size of *P. m. nitidula* and *P. modica*, and to be compared with those forms, with one of which it may very likely prove identical. The description is abbreviated from Jousseaume, and his figure is copied, as no Venezuelan specimens of *Pupoides* are at hand.

3. PUPOIDES MODICUS (Gould). Pl. 12, figs. 13, 14, 15.

The shell is perforate, rimate, tapering from the last whorl to the obtuse summit, thin, dull brown, somewhat glossy, irregularly striate. The whorls are strongly convex, the last ascending in front. The aperture is oval. Peristome thin, broadly expanded, very little or not thickened within, white, the outer margin regularly curved, columellar margin straightened, margins converging and joined by a transparent callus. No callous pad or tubercle in the angle.

Length 4.2, diam, 2.1 mm.; 5 whorls.

Length 3.9, diam. 2.15 mm.; 5 whorls.

Length 3.45, diam. 1.8 mm.; 4¾ whorls.

St. Simon's Island, Georgia, and Cedar Keys, Florida, to Key West; near the coast. Bimini Keys, Bahamas (G. H. Clapp).

Pupa modica Gld., Proc. Boston Soc. N. H., iii, 1848, p. 40 (Florida); Terr. Moll., ii, p. 318, pl. 52, f. 2.—W. G. BINNEY, Terr. Moll., v, p. 204, pl. 52, f. 2. — *Pupoides modicus* Gld., VANATTA, Nautilus, xxi, pp. 100-104 (Florida Keys).—CLAPP, Nautilus, xxvii, p. 64 (Bimini Is.).—WALKER, Nautilus, xxxi, pp. 54, 56 (between Chester shoal and Cape Canaveral, Palm Beach, Long Key).

The shell is smaller and thinner than *P. marginatus*, somewhat more striate, the lip very little or not thickened. The last character is about all that separates *modicus* from the Antillean *P. marginatus nitidulus*, which is about the same size, and when not quite mature cannot be distinguished. The angular tubercle is sometimes practically wanting in small forms of *P. marginatus*. Key West examples are figured.

Dr. Clapp found *P. modicus* on South Bimini, North Cat

and South Cat, of the Bimini group, on the extreme west of the Bahamas, separated from Florida by the Gulf Stream.

4. PUPOIDES HORDACEUS (Gabb). Pl. 12, figs. 11, 12.

The shell is imperforate, shortly rimate; cylindric, with a convexly conic summit and obtuse apex; cinnamon to avellaneous, without gloss, the apex and lip pale. The upper whorls are strongly convex, the last two weakly convex or somewhat compressed laterally. Sculpture of slender retractive riblets, nearly straight, widely spaced, wanting on the first 1½ whorls, which are weakly, densely, microscopically granulose. The aperture is slightly oblique, oval, angular above. The peristome is narrowly expanded, strongly thickened within. Parietal margin strongly oblique, covered with a very thin callus. There is no angular tubercle or callus.

Length 3.35, diam. 1.5 mm.; 5⅓ whorls. Jerome.

Length 3.9, diam. 1.65 mm.; 5½ whorls. Jerome.

Length 3.65, diam. 1.65 mm.; 5⅓ whorls. Adamana.

Length 4.3, diam. 1.7 mm.; 5¾ whorls. Adamana.

Las Vegas, New Mexico, and western San Miguel Co., Colorado, west to Mt. Trumbull and Jerome, Arizona, south to Mesilla, N. M., and Benson, Arizona.

Pupa hordacea GABB, Amer. Jour. Conch., ii, p. 331, pl. 21, fig. 7 (1866). Not *Pupa hordeacea* W. G. Binney; not *Bifidaria hordeacea* Sterki. — *Pupoides hordaceus* (Gabb), PILSBRY & VANATTA, Proc. A. N. S. Phila., 1900, p. 588, pl. 22, f. 11. — WALKER, Occ. Papers Mus. Zool. Univ. Mich., no. 15, 1915, pp. 2-4 (distribution).

Pupa arizonensis Gabb, W. G. BINNEY, Land and Fresh-Water Shells of North America, 1869, part i, p. 240, fig. 416; and in subsequent works. Not *P. arizonensis* Gabb.

Pupa arizonensis W. G. Binney, STERKI, Nautilus, iii, pp. 118, 119.

Pupa gabbi DALL, Proc. U. S. Nat. Mus., vol. xix, 1896, p. 367, new name for *P. arizonensis* Binney not Gabb.

Bifidaria hebes Ancey, PILSBRY, Classified Cat., p. 19; Nautilus, xi, 1898, p. 117. Not of Ancey.

Pupa gabbi mexicanorum CKLL., Nautilus, x, April, 1897, p. 143 (Rio Grande, Mesilla, N. M.).

This toothless cylindric snail resembles the following species, but is quite unlike any other of our fauna. It was one of our rarest and least known species before 1900, but since that time has often been taken in abundance. Its earlier adventures under various aliases have been discussed in my paper of 1900.

Gabb did not notice the ribs, which are often partially lost by wear, but they are present though weak by wear in the only one of his specimens preserved. The original description follows.

Pupa hordacea Gabb. Description.—Shell very small, cylindrical; apex obtuse; whorls 6, convex; suture well impressed, smooth, thin, horn-color; aperture small, rounded below, unarmed, lip narrowly reflected and white; base umbilicate, the umbilicus bounded by an angle.

Dimensions.—Length .11, width .04 inch.

Locality.—With the preceding [Fort Grant, near the junction of the Arivapa and San Pedro rivers, Ariz. Collected by Dr. G. H. Horn].

This is a species of the arid plateaus and foothills, never found in the humid upper zone of the mountains. It is known by specimens taken in the débris of streams or in Pleistocene or later deposits. The Mesilla specimens may have floated from the upper river; those from the San Pedro at Benson certainly came from further south, and the type lot also may have been from the San Pedro drift. Westward from Benson, in Pima County, we saw nothing of it; but it penetrates westward further north. It appears to be most abundant in the northern counties of Arizona, extending north to San Miguel Co., Colorado, near the Utah line. Specimens from this place measure from length 4.15, diam. 1.6, aperture 1.4 mm., barely 6 whorls, to length 3.3, diam. 1.6, aperture 1.3 mm., 5¼ whorls.

In the deposits at Las Vegas, N. M., at its northeastern extreme limit, it occurs with *P. inornatus,* which here reaches its southern limit as now known. The localities follow.

Colorado: Dolores canyon at mouth of Gypsum Creek, San Miguel Co. (Junius Henderson, 1914).

New Mexico: near Las Vegas (Prof. Cockerell, Mary Cooper); Rio Grande drift at Albuquerque (Ferriss & Pilsbry); Grant (A. and J. Baily); Rio Grande drift at Mesilla (Cockerell). Canones Creek east of Mt. Pedernal, Coyote Creek near Rio Puerco and Arroyo Agua and Rio Puerco, all in Rio Arribo Co.; 14 miles north of Tucumcari (Walker).

Arizona: Navajo Springs (Ashmun), Chinle Creek and near Adamana, Apache Co. (Ferriss); Holbrook, Navajo Co. (Ashmun); Antelope Valley and Finley's reservoir, near Mt. Trumbull, Coconino Co. (Ferriss and Daniels); Verde River near Jerome, Yavapai Co. (Ashmun); Ft. Grant, Pinal Co. (G. H. Horn, type locality); San Pedro drift, near Benson, Cochise Co. (Pilsbry); Ft. Defiance, in drift (Walker).

5. Pupoides inornatus Vanatta. Pl. 12, fig. 10.

Shell similar to *P. hordaceus* except that the upper part tapers slightly more, and the surface is nearly smooth, with some irregularly developed striæ only, weaker near the suture.

Length 3.6, diam. 1.6 mm.; 5½ whorls. Type.

Length 3.4, diam. 1.57 mm.; 5½ whorls. Pike's Peak.

South Dakota: drift of White River, Washington Co. (type loc.), and Indian Creek, Pennington Co. (W. H. Over). Colorado: Pike's Peak (E. Hall); Trinidad (Pilsbry); Round Mountain, Custer Co. (Cockerell); Bellevue, Larimer Co. (J. Henderson). New Mexico: Arroyo Pecos, near Las Vegas, in ant hills, flood débris and in the "charcoal zone" (T. D. A. Cockerell).

Pupoides inornatus Van., Nautilus, xxix, Dec. 1915, p. 95. —*? Pupa hordeacea* Gabb, Sampson, Nautilus, vi, 1893, p. 102 (William's canyon, Manitou, Colo.). — *Pupoides hordaceus* (Gabb), Pilsbry and Cockerell, Nautilus, xiv, 1900, p. 86.— J. Henderson, Univ. of Colo. Studies, iv, p. 170; ix, 1912, p. 57. — *Pupa arizonensis* var. nov. *saxicola* Cockerell, Zoe, ii, April, 1891, p. 18 (under rocks on Round Mountain, Custer Co., Colorado). Not *Pupa saxicola* Lowe.

In a considerable number seen, this form differs constantly from *P. hordaceus*. It appears to be a species of the Rocky Mountains, spreading eastward, while *hordaceus* ranges southwestward, the areas overlapping at Las Vegas.

No "live" specimens have been seen; those from South Dakota and Las Vegas, though sometimes retaining the cinnamon color, may be Pleistocene or later fossils washed into the streams. Apparently it still lives in Colorado, as the Pike's Peak shells are quite fresh. By correspondence with Junius Henderson and the examination of specimens it appears that all published Colorado records for *hordaceus* were based on specimens of *inornatus*, with the possible exception of Sampson's Williams canyon record (Nautilus, vi, 102), which has not been re-examined. The true *P. hordaceus* is known to occur only in the extreme southwestern part of the state, west of the Rocky Mountains.

Professor Cockerell seems to have been the first to find this shell, but unfortunately he described it quite briefly, without mention of the sculpture, and used a preoccupied name. I have not seen his *P. a.* var. *saxicola*, but it is now regarded by him as identical with *inornatus*. Later Mr. Vanatta, who had access to large numbers of the true *P. hordaceus*, noticed the difference in sculpture.

6. Pupoides chordatus (Pfeiffer). Pl. 11, figs. 14, 15.

Shell rimate, cylindric-oblong, thin, sculptured with oblique, rather distant, cord-like riblets, pellucid, corneous. Spire long, the apex obtuse. Whorls 5½, moderately convex, the last slightly over one-fourth the length, rounded at base. Aperture oblique, oval; peristome white-lipped, shortly expanded throughout, the margins somewhat approaching, columellar margin slightly arcuate. Length 4, diam. 1 mm.; aperture slightly more than 1 mm. long (*Pfr.*).

Mexico: Mazatlan (E. Klocke).

Bulimus chordatus Pfr., Malak. Blätter, iii, 1856, p. 46; Monogr. Hel. Viv., iv, p. 420; Novit. Conch.., iii, p. 440, pl. 94, f. 3-6.—*Pupa chordata* Pfr., Binney & Bland, Land and Freshwater Shells of N. A., i, 1869, p. 241, f. 418.—*Pupoides chordatus* Pfr., Martens, Biologia Centrali-Americana, Moll., p. 330.—Kobelt, Conchyl.-Cab., *Buliminidæ*, p. 921, pl. 130, f. 5, 6.—*Pupa choroata* Schaufuss in Paetel's Cat., p. 84.

More delicate and more tapering than *P. hordaceus*, the

riblets sometimes partially obsolete, and there is a small angular tubercle inward from the insertion of the lip. The color is decidedly brownish corneous, the lip paler but not white. A specimen received from Schaufuss, probably from the original lot, measures: length 3.54, diam. 1.34, length of aperture 1.05 mm.; 5½ whorls (fig. 14). Pfeiffer's dimensions were evidently only approximate, as the ratio of diameter to length does not agree with his figures, one of which is copied in fig. 15.

7. Pupoides paredesii (Orb.). Pl. 11, figs. 10-12.

The shell is oblong, pupoid, umbilicate, thin, marked longitudinally with raised ribs, widely spaced. Spire nearly cylindric with abruptly truncate summit, composed of 6 convex, rounded whorls separated by a deep suture. Aperture oval, without teeth, having the peristome thick, a little reflected. Color uniform dirty fawn, the aperture whitish. Length 5, diam. 2 mm. (*Orb.*).

Bolivia: near La Paz, on the road *los Obrages,* elevation not less than 3600 m., on walls and under stones under bushes (type loc.). Also a smaller form [*limensis* Phil.] near Lima, Peru, at the foot of Mount San Cristobal, under stones in somewhat humid places, only a few hundred meters above sea level (Orbigny).

Helix paredesii Orbigny, Mag. de Zool., 1835, p. 21.—*Pupa paredesii* Orb., Voy. dans l'Amérique Méridionale, Mollusques, p. 322, pl. 41, f. 3-6.—Hidalgo, Journ. de Conchyl., 1870, p. 65 (Lima, Peru; Guayaquil, Ecuador; Cobija, Bolivia, *Paz*).—*Pupoides paredesii* Orb., Kobelt, Conchyl.-Cab., *Buliminidæ*, p. 921, pl. 130, f. 7, 8.

D'Orbigny notes the unusual distribution of this species, from the cold zone of La Paz to the hot region of Lima; he could find no difference in the shells except that those of Lima are smaller. I have not seen topotypic *paredesii* but only the Lima form, *limensis* Phil., which may perhaps prove to be a subspecies.

P. limensis (Philippi). Pl. 11, figs. 18, 19. Shell rimate, subcylindric, with tapering apex, thin, white, obliquely striate-

costulate. Whorls 6, convex, the last scarcely one-third of the length. Aperture oval, vertical, the peristome expanded, reflected, margins joined by a callus. Length 4¼, diam. 2 mm. (*Phil.*).

Peru: Mt. St. Bartolome near Lima (Philippi); Lima (Paz).

Pupa limensis PHIL., Malak. Blätter, xiv, 1867, p. 75.—PFEIFFER, Monogr. Hel. Viv., vi, 299.

Philippi's type was bleached. Fresh shells are avellaneous (brownish-corneous), dull, with thread-like, widely-spaced riblets. The peristome is narrow, expanded, whitish, not thickened. There is no angular tubercle or callus. Though subcylindric, it tapers more than *P. hordaceus*.

Length 4.65, diam. 1.75 mm.; 5⅔ whorls.

Length 4.14, diam. 1.72 mm.; 5⅓ whorls.

Length 4.4, diam. 1.7 mm.; 5½ whorls.

This shell seems to be abundant at Lima. It requires renewed comparison with typical *paredesii* of the high sierra; by reason of its very different zonal relation, it may be racially distinct.

II. SPECIES OF THE ORIENTAL AND ETHIOPIAN REGIONS.

These forms differ from the North American by having the tuberculiform angular lamella separated from the lip-insertion, though contiguous to it. Rarely it is wanting.

Some 27 supposed species have been named; possibly a third of these are really distinguishable as species or races; but the materials for a revision are not contained in any one museum. Most of them were described without comparisons with already known species, and the characters depended upon for specific distinction—chiefly size and degree of elongation—are highly variable in the American *P. marginatus*. I doubt their racial value in the *cænopictus* group.

No less than seven supposed species have been described or reported from Aden, probably all from the debris along occasional torrents. In Arizona I have noticed great variety in the size and shape of *P. marginatus* found under similar conditions, doubtless due to the mingling of shells out of different colonies. Under the circumstances I can do little more than give the published descriptions, grouped geographically.

8. Pupoides tutulus (Reeve). Pl. 13, figs. 16, 17, 18.

Shell conical, rather broad at the base, compressly umbilicated, whorls 6 in number, rounded, very minutely striated; columella very broadly vertically dilated, with a small callosity above. Aperture nearly round, lip slightly reflected. Light chestnut, somewhat horny, callosity white (*Reeve*).

Length 5½, diam. 3 mm.; aperture 2 x 1⅔ mm. (*Pfr.*).

India: Humeerpore, Bundelkhund (Benson); Delhi and Nagpore (Wood-Mason); Kutch and Sind (Stoliczka, Blanford); Patna (Mainwaring).

Bulimus tutulus Benson, MS., Reeve, Conch. Icon., v, December, 1849, pl. 84, f. 625.—*Pupa tutula* Benson, Kuester, Conchyl. Cab., p. 133, pl. 17, f. 8-10. — Pfeiffer, Mon. Hel. Viv., iii, 1853, p. 535. — Hanley and Theobald, Conch. Indica, 1876, pl. 156, f. 6.—Nevill, Handlist Moll. Ind. Mus., i, 1878, p. 194. — *Pupoides tutulus* Reeve, Gude, Fauna Brit. India Moll., ii, p. 261.

More broadly conic than any other species. The figures of Reeve (fig. 18) and Kuester (figs. 16, 17) are copied.

9. Pupoides dorle (Issel). Pl. 17, figs. 5, 6.

Shell rimate, ovate-elongate, tapering, corneous, glossy, under a lens obliquely striate; apex corneous, obtuse, suture impressed. Whorls 7½, a little convex, the last somewhat swollen, a little ascending to the aperture, compressed at the perforation. Aperture rotund, ⅓ the length; peristome white, a little expanded, flatly reflected, the columellar margin arcuate, outer margin strongly curved, margins strongly converging; parietal wall having a white tubercle at the angle of the aperture. Length 6⅓, diam. 2 mm. (*Issel*).

Persia: near the wall about the garden of *Haescht Behescht*, Ispahan (Doria).

Bulimus doric Issel, Molluschi raccolti dalla Missione Italiana in Persia, 1865, p. 33, pl. 2, f. 29-32.

This is the largest of the genus, with more whorls than *lardeus* or other related species. The original figures are reproduced.

10. Pupoides cœnopictus (Hutton). Pl. 13, figs. 1, 2, 3.

The shell is cylindric-turrited, deeply rimate, cinnamon-brown or paler, lightly striate. The whorls are strongly convex, regularly increasing to the penult, which is somewhat more swollen. The aperture is ovate; peristome rather broadly, flatly reflected, strongly thickened within, thin at the edge; outer margin regularly curved throughout, an angular tubercle below its posterior insertion and separated from it by a groove. Parietal callus thin and short.

Length 5.1, diam. 2.4 mm.; 6 whorls (Bombay).

Length 4.8, diam. 2.2 mm.; 5¾ whorls (Bombay).

India: Salt Range, Kashmir, N. W. Punjab (Theobald); Beeana near Agra (Hutton, type loc.); Delhi, Roorkee (Wood-Mason); Patna (Mainwaring); Kutch (Stoliczka); Trichinopoly, Erode (Blanford); Travancore (Beddome); Dinapur, Kurnal (Bacon); Bombay (Peile). Ceylon (Nevill, Beddome). Afghanistan (Hutton).

Introduced in Jansenville, Cape Prov., South Africa (H. C. Burnup), Cuba (Arango) and Porto Rico (Swift).

No. 7. — *Pupa. Pupa cœnopicta?* Hutton, Journ. A. S. Beng., iii, 1834, pp. 85, 93.—*Pupa cœnopicta* Hutton, J. A. S. B., xviii, 1849, p. 654.—Morelet, Ann. Mus. Civ. Genova, iii, 1872, p. 200.—Nevill, Handlist Moll. Ind. Mus., i, 1878, p. 193; Zool. Res. Exp. W. Yunnan, i, 1879, p. 882.—Peile, Journ. Bombay Nat. Hist. Soc., xi, 1908, p. 131.—Blanford, J. A. S. B., vol. 44, 1875, p. 45 (Aden forms). — *Pupoides cœnopictus* Hutt., Kobelt, Syst. Conchyl. Cab. Buliminidæ, p. 918, pl. 130, f. 22, 23.—Gude, Fauna British India, Moll., ii, p. 259.—*Buliminus fallax* Say, Jickeli, Nova Acta K. Leop.-Carol. Akad. Nat. Cur., vol. 37, 1874, p. 97, pl. 2, f. 1 (jaw), pl. 5, f. 1 (shell): Abyssinian forms. — *Buliminus (Ena) cœnopictus* Hutton, Dautzenberg, Mém. Soc. Zool. France, iii, 1890, p. 129, pl. 1, f. 4*a*, *b* (Bakel, Senegal).—*Bulimus cœnopictus* Hutton, Hanley & Theobald, Conch. Indica, p. 12, pl. 23, f. 9 (Afghanistan etc., Upper Birmah). — W. Blanford, J. A. S. B., xxxi, 1862, p. 136 (small variety; close to Myanoung on the banks of the Irrawaddy; neighborhood of Ava). —*Peronæus cœnopictus* Hutton, Theobald, J. A. S. B., 1878,

pp. 144, 148 (northwestern Punjab, under stones, variable).

I take the typical *cœnopictus* to be the more slender, darker-colored Indian form. Hutton's insufficient description appears to indicate this form, which has been figured as *cœnopictus* in the Conchologia Iconica and Conchologia Indica. Pfeiffer figured a more obese, conic form in the Conchylien-Cabinet. Somebody ought to look it up at Hutton's type locality; the exact spot should be easily found. Hutton writes: "The shell is covered over with a coating of mud. These little shells I found at Beana; they were adhering to the face of a bare and very steep rock. . . . They were scattered over the bleak face of the rock in great numbers." He mentions also (p. 88) that the rock faced east.

Benson (1849) wrote: "I found the species abundant under stones and rocks at Delhi, and Dr. Bacon met with it in great profusion at Kurnal on mud walls and under tiles. It has never occurred to me or to my correspondents on the left bank of the Jumna nor of the Ganges. Dr. Bacon found a specimen or two at Dinapore on the right bank of the latter river, so that it has an extensive range to the south and west of those streams."

A. Morelet (Annali Museo Civ. de Storia Nat. di Genova, iii, 1872, p. 200) has discussed the cœnopict forms described from Arabia and Africa, reducing *senegalensis, putilla, sennaariensis, cerealis* and *vermiformis* to synonyms of *cœnopictus;* even *gemmula* he thinks may be an insular form diminished in size by the remarkable aridity of the Cape Verde Island climate.

Jickeli reduced all forms of the genus known to him to a single species which he called *B. fallax* Say. This view is certainly untenable, as the American and Australian species at least are quite distinct from the Asiatic and African; yet it may be doubted whether the following Asiatic and African forms, as far as my No. 21, are specifically distinct from *cœnopictus.*

P. cœnopictus appears to have been introduced in Cuba and Porto Rico more than fifty years ago. Specimens from

Havana (R. Arango) are about typical in proportions (pl. 13, fig. 3). Porto Rico has both the typical and the *lardeus* (pl. 13, fig. 4) forms, collected by R. Swift. It is easily separated from *marginatus* and *nitidulus* by the even curve of the outer lip, not more strongly arcuate above, and by the angular tubercle, distinctly separated from the outer lip. The specimens before me, from four sources, were labelled *marginatus, fallax* and *nitidulus*. I do not know that it has been found in the West Indies recently.

In South Africa *P. cænopictus* has been found at Jansonville according to specimens sent by Mr. H. C. Burnup, probably introduced from India. It occurs in East Africa (as *L. soror* Prest.); also in West Africa, for in my opinion *P. senegalensis* is not really distinct. In deference to the views of several excellent conchologists and in view of some trivial differences it is herein allowed subspecific rank. See No. 20.

Leucochiloides soror Preston (pl. 14, fig. 7; pl. 17, fig. 3). Very closely allied to *L. chanlerensis* and possibly only a variety of that species; it differs, however, in its larger size, more open umbilicus, though having a proportionately narrower base, and in having an additional whorl, the aperture is also more ovate than is the case in that species. Alt. 6, diam. maj. 2.25 mm. Aperture alt. 1.5, diam. 1.25 mm. (*Preston*, P. Z. S., 1912, p. 188, pl. 31, f. 17).

British East Africa: Chanler Falls, Eusso Nyiro (Robin Kemp).

Nothing differentiating this from *P. cænopictus* has been pointed out, and I can find no differences in two topotypes from the author examined, one of which is drawn in pl. 17, fig. 3 (No. 41591 B. Walker coll.). It measures: length 5.35, diam. 2.4 mm.; almost 7 whorls.

Hutton's two descriptions of *cænopictus* follow.

Shell about 2½ lines in length; whorls 8; spire rather obtuse; colour brown; aperture rounded, margins reflected and interrupted by the body-whorl. Animal with four tentacles buttoned at the tips, the upper pair longest and bearing the eyes at the summit; colour blackish (*Hutton*, 1834).

Shell cylindrico-pyramidal, with 6 whorls, minutely striate;

body-whorl ventricose, the others gradually tapering to an obtuse apex; aperture ovate-lunate, lips subreflected and white within; a single tooth at the junction of the outer lip with the body-whorl; colour brown (*Hutton*, 1849).

Bulimus astierianus Dupuy (pl. 13, figs. 5, 6). Shell conoid, apex obtuse; perforate; under the lens very delicately and irregularly striatulate; aperture ovate, a little lunate; peristome spreading, flat, acute, lipped and somewhat thickened with brownish-white; whorls 6, convex, parted by a deep suture, the last whorl larger, forming half the shell. Rather solid, with a somewhat silky luster, tawny, glabrous and subopaque. Length 5 to 6, diam. 2 mm. Ile de Ste-Marguerite. "Il avait été recueilli sur des affûts de canons par un ami de M. Astier" (*Dupuy*).

Bulimus astierianus Dupuy, Hist. Nat. Moll. France, 1849, p. 320, pl 15, f. 7.—*Ena astieri* Caziot, Etude Moll. Monaco, 1910, p. 308.

Kobelt, Caziot and others have commented on the evidently exotic origin of this species. Even the collector is unknown, and it has not been found a second time. In so difficult a group, the exact identity of the form cannot be decided unless the type is found, but it is not unlikely identical with *cœnopictus*.

10*a*. *P. cœnopictus lardeus* (Pfr.). Pl. 13, figs. 4, 9, 12.

Shell subperforate, oblong-ovate, rather solid, striate, having the luster of lard, rufous-corneous. Spire convexly turrited, the apex obtuse; whorls 6, a little convex, the last slightly more than one-third the length, somewhat compressed at base. Aperture subvertical, truncate-oval; peristome lipped within, subangularly spreading, the margins remote, joined by a thin callus which bears an obsolete fold at the right lip-insertion. Length 5½, diam. 2⅓, aperture 2 x 1½ mm. (*Pfr.*).

India.

Bulimus lardeus Pfr., Proc. Zool. Soc, 1852, p. 157; Monogr. Hel. Viv., iii, p. 348; Conchylien-Cabinet, *Bulimus*, p. 151, pl. 39, f. 14-16.—*Pupoides lardeus* Pfr., Gude, Fauna Br. India, Moll., ii, p. 261.

Slightly larger and more robust than *cænopictus,* but at best it seems scarcely distinct as a species. Hanley and Theobald have stated (Conch. Indica, p. x, footnote 13) that "the types of the *B. lardeus* Pfeiffer belong to this species" (*cænopictus*). Gude notes that it "is perhaps only a variety of *P. cænopictus,* is larger, possessing one more whorl, and is more conoid in the spire."

A large specimen (fig. 9) measures: length 5.8, diam. 3.5 mm., aperture 2.5 mm. long, 6 whorls. The peristome is broader than in *cænopictus* in these specimens. The type figure is copied in fig. 12.

10*b*. *P. cænopictus samavaensis* (Palad.). Pl. 13, figs. 8, 10, 11.

There is a rather obese form in India, associated with typical *cænopictus* in one lot from Bombay, which differs by its broader shape, light pinkish cinnamon color, decidedly paler than *cænopictus,* and rather wider lip. I have referred these shells to *samavaensis,* described from Aden, as they seem to agree well with the description and figure given by Paladilhe. Figs. 10, 11 are Bombay specimens. For the original description of *samavaensis* see below.

Length 5.5, diam. 2.8, length aperture 2.68 mm.; 5⅔ whorls.

Length 4.9, diam. 2.75, length aperture 2.1 mm.; 5½ whorls.

This appears to be what Pfeiffer figured (Conchylien-Cabinet) as *cænopictus,* the specimens received from Benson.

Bulimus samavaensis Paladilhe (pl. 13, fig. 8). — Shell obliquely and compressly rimate-umbilicate, rather obesely conoid, rather thin, subopaque, slightly reddish corneous, a little shining, slightly substriatulate. Spire somewhat long, apex obtuse, submamillate; whorls 6, rather convex, regularly and rather rapidly increasing, separated by a narrow, deep suture; last whorl at the aperture nearly ⅔ the length, abruptly, strongly but shortly ascending at the aperture; free margin somewhat excavated, a little oblique. Aperture subelongate-rounded, slightly oblique; peristome interrupted, strongly reflected, the right margin somewhat arcuate, an elongate fold near the insertion; columellar margin a little concave towards the aperture, margins slightly converging above. Length 5, diam. 2.5 mm. (*Paladilhe*).

Arabia: Aden (Paladilhe).

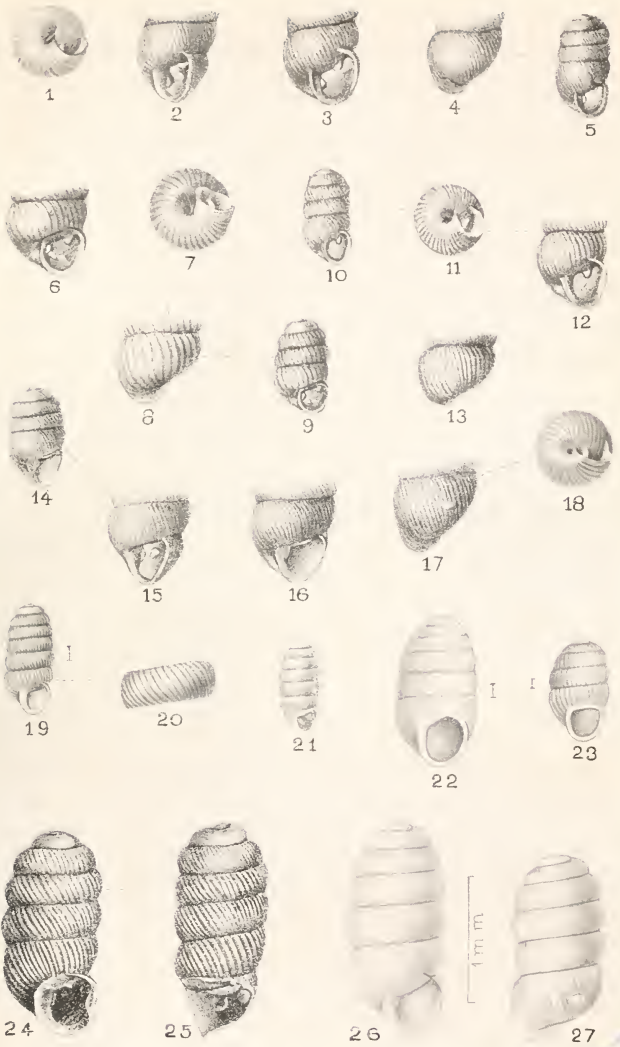
Bulimus samavaensis (Mousson MS.) Paladilhe, Ann. Mus. Civ. di Stor. Nat. Genova, iii, 1872, p. 14, pl. 1, f. 20, 21.

Specimens submitted by Paladilhe to Mousson were considered by the latter the same as his then undescribed *B. samavaensis* from the Euphrates. Subsequently Mousson described this or a closely related form as *Buliminus samavaensis* (Journal de Conchyliologie, 1874, p. 38), from riverside thickets at Samava, where it is abundant. He mentions having a closely similar form from Aden, and three specimens from the island of Ghaes in the Persian Gulf. As Paladilhe had already defined the Aden form under the name *samavaensis*, Mousson's description need not be quoted. Bourguignat considered this or another Samava form distinct, describing it as *B. euphraticus*.

10*c*. *Bulimus euphraticus* Bgt.—Shell rimate, obesely ovate and ventricose, subopaque, corneous, obliquely and very sharply striate. Spire acuminate-subelongate, apex very large, smooth, glossy obtuse; whorls 5½, convex, regularly increasing, parted by an impressed suture, the last ⅔ the length, rotund, ascending to the lip insertion. Aperture oblique, lunate, semirotund; peristome corneous, thick, flatly expanded and acutely reflected; columella deep within, straight; margins rather approaching, joined by a very thin callus bearing a tooth at the insertion of the lip. Length 4½, diam 2½ mm.

This Bulime, which has been confused with the *B. samavaensis*, inhabits the banks of the Euphrates in the neighborhood of Samava (*Bourguignat*, Species Novissimæ etc., 1876, p. 22).

10*d*. *Bulimus maharasicus* Bgt. Shell rimate, obesely tumid, oblong, buff-corneous, obliquely very sharply striatulate. Spire oblong-acuminate and slightly ventricose, apex obtuse, smooth. Whorls 6, convex, regularly increasing, separated by a moderately impressed suture, the last whorl ⅔ the length, rotund, at the aperture slowly but strongly ascending. Aperture nearly vertical, lunate, semirotund, rather thrown to the right; peristome corneous, thick, robust, broadly and flatly expanded and acutely reflected throughout; columellar margin broadly expanded; margins rather remote, joined by a thin callus bearing a tooth at the insertion of the lip. Length 6, diam. 2¾ mm. (*Bourguignat*, Species Novissimæ, Moll., 1876, p. 21).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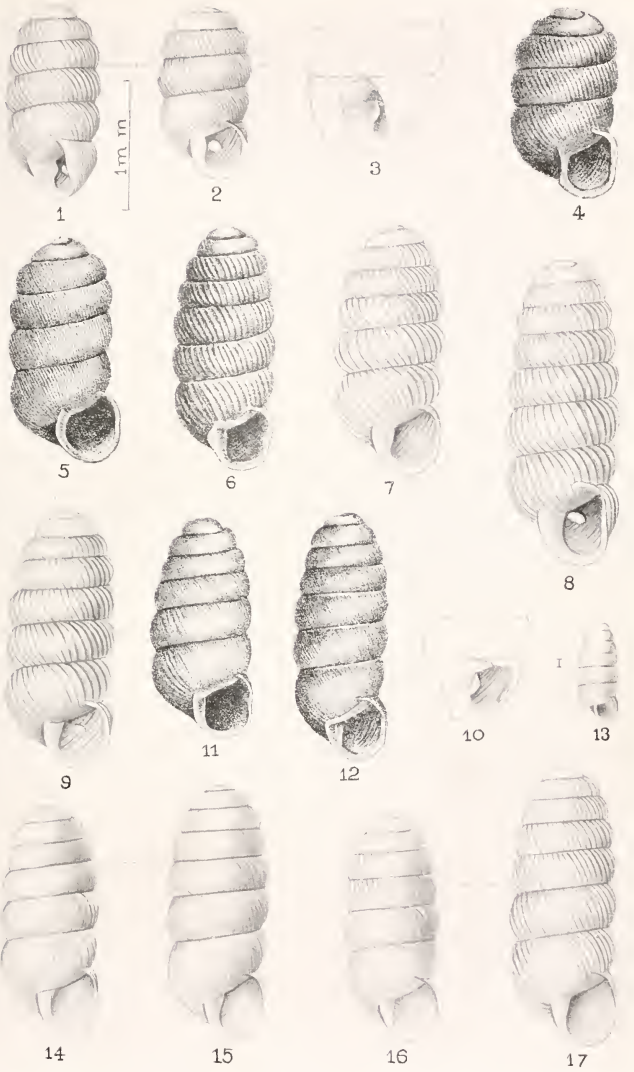
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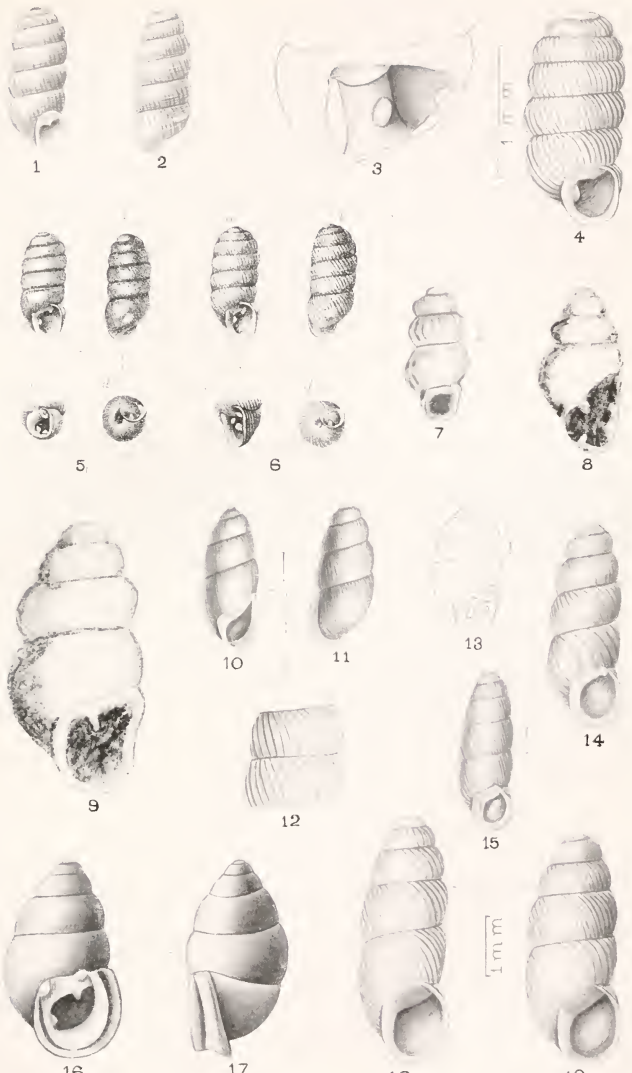
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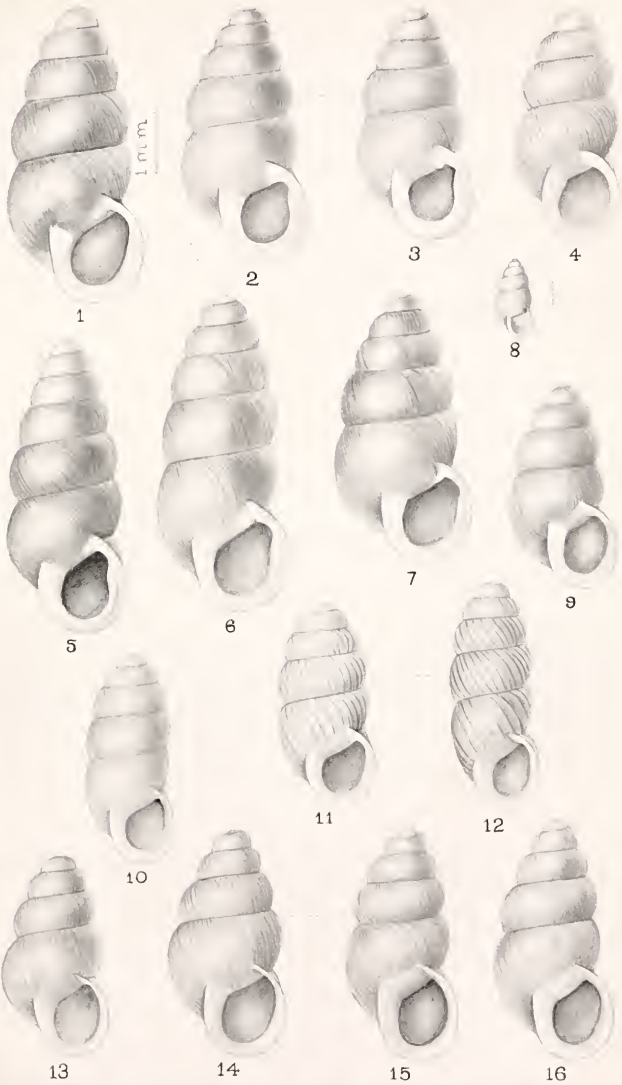
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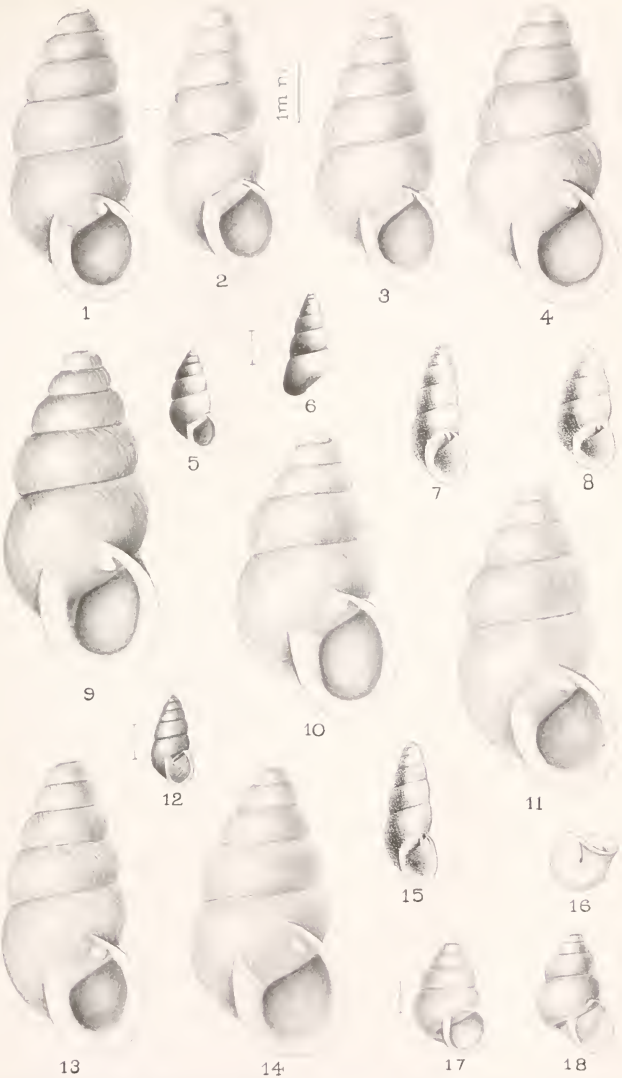
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Arabia: Djebel-Maharas, 10 leagues north of Aden (Col. du Couret); Kursi, Aden (Issel).

Seems to be a large form of "*samavaensis*".

10*e*. *Bulimus marebiensis* Bgt. — Shell rimate-perforate, elongate-oblong, subopaque, corneous, glossy, nearly smooth or, under a very strong lens, obliquely strongly radiatulate. Spire acuminate-elongate, apex smooth, glossy, rather obtuse; whorls 6½, convex, regularly increasing, separated by an impressed suture, the last whorl ⅔ the length, rotund, at the aperture rather strongly ascending. Aperture oblique, a little lunate, ovate; peristome whitish, thick, flatly expanded and acutely reflected throughout; columella short, immersed, straight; margins approaching, joined by a thin callus bearing a tooth at the insertion of the lip. Length 5, diam. 2 mm. Environs of the town of Mareb, at the ruins of the ancient Saba, Arabia, found by Colonel L. du Couret (*Bourguignat*, Species Novissimæ, 1876, p. 23).

10*f*. *Bulimus vermiformis* Palad. (pl. 13, fig. 15). — Shell rimate, elongate-subcylindroid, slightly fusiform, corneous, somewhat tawny, rather thin, inconspicuously striatulate in places, little shining, slightly pellucid. Spire drawn out, conic-tapering; whorls 7, convexly swollen, slowly and rather regularly increasing, separated by an impressed suture; last whorl a little larger than the penult, at aperture slightly more than ¼ the length; free margin somewhat arcuate, suboblique to the axis of the shell, regularly, slowly ascending to the insertion. Aperture rounded-elongate, peristome disjoined, simple, a little reflected, the right margin subarcuate, a fold in the parietal margin contiguous to the insertion; columellar margin a little excavated; basal rounded; the margins narrowly but strongly reflected outward. Length 5, diam. 1½ mm. (*Paladilhe*).

Arabia: Aden (Issel).

Bulimus vermiformis Paladilhe, Ann. Mus. Civ. Genova, iii, 1872, p. 15, pl. 1, f. 24, 25.

Paladilhe states that some specimens have up to 7½ whorls.

The Aden forms collected by A. Issel were from débris of the Kursi, a watercourse dry most of the time. The shells are washed down from the high interior of Yemen, and, as usual, forms from many colonies are mingled, hence the variety in form and size.

11. PUPOIDES KURSIENSIS (Bourguignat). — Shell perforate (the perforation punctiform), elongate-ventricose, slightly fusiform, glossy, pale corneous, almost smooth, but under a very strong lens, very sharply and obliquely radiatulate. Spire somewhat swollen, acuminate-oblong; apex glossy, smooth, a little whitish, very obtuse as though mamillate. Whorls 6 (the upper convexly rotund, the third a little convex), regularly increasing, separated by a little-impressed suture, the last whorl nearly ⅓ the length, narrow, little convex, suddenly, slightly ascending at the insertion of the lip. Aperture very oblique, quite small, lunate, oblong, rather narrow transversely; peristome flatly expanded and a little reflected. Columella straight, immersed; margins remote, joined by a very thin callus, a hardly noticeable tooth-like callus at the insertion of the lip. Length 5, diam. 3½ mm. (*Bgt.*).

Arabia: Kursi, near Aden.

Bulimus kursiensis BOURGUIGNAT, Species Novissimæ, 1876, p. 23.

It seems to be much more ventricose than *P. C. samavaensis* or even *P. tutulus*, and must be a distinct species if Bourguignat's measurements are correct.

12. PUPOIDES RAGIUS (Jousseaume). — Shell rimate (the rimation deep, straightly elongate), minute, oblong, subtranslucid, a little glossy, pale corneous, finely striatulate. Spire oblong, rather regularly tapering, obtuse at the apex. Whorls 6, convex, as though swollen, separated by a deep suture, the last whorl rounded, relatively strongly ascending, and somewhat bag-shaped. Aperture nearly vertical, semiovate, conspicuously turned towards the right; peristome white-lipped and reflected throughout, the margins joined by a thin callus bearing a strong tubercle on the right. Length 4, diam. 2, alt. apert. 1.25 mm. (*Jouss.*).

Arabia: near Aden in the drift of a small stream; also in the environs of Massaua on the Abyssinian side (*Jousseaume*).

Bulimus ragius JOUSS., Bull. Soc. Malacol. France, vi, 1889, p. 347.

This Bulime, of the series of *B. cænopictus* cannot be assimilated to any of the Arabian cœnopict forms, being sharply distinguished by the deviating and strongly ascending last whorl, by the excentric aperture, carried far to the

right, and by the umbilical crevice, of which the depth and length are due to the deviation of the last whorl (*Jousseaume*).

Possibly a form of *P. sennaariensis*, but if the characters described are constant, it would appear to be readily distinguishable.

13. Pupoides sennaariensis (Pfr.). Pl. 14, figs. 1, 2.

Shell perforate, oblong-turrited, thin, very lightly striatulate, little shining, brownish-corneous. Spire subregularly tapering, apex obtuse. Whorls 7, convex, the last about one-third the length, compressed around the impervious perforation. Aperture slightly oblique, truncate-oblong, with an entering parietal [angular] lamella almost at the angle of the right margin; peristome thin, slightly spreading, somewhat lipped within. Length 4, diam. 1.5 mm., aperture 1⅓ mm. long (*Pfr.*).

Eritrea: Sched Said near Massaua, and Dahlak, islands in the Red Sea; Sa'ati; Ailet; on the road from Zebergoma to Asmara; Massaua (Raffray).

Abyssinia: in Ansebaland at Beniamer, Adobha-abi near Hasta, 2133 ft., on the Obellet; near Weld Jawa, 2814 ft., on the Gaboba; in Habab, Nakfa, 2644 ft. (Jickeli). Meshek (Blanford). Plateau of Hamacen and on the col of Abouna Yousef, 4024 m. (Raffray). Sennaar (Darnaud, type locality).

Egypt: Cairo, garden of the College of Ste. Famille; Wadi-Hoff near Hélouan (R. P. Teilhard).

Pupa sennaariensis Pfr., Malak. Bl., 1855, p. 177; P. Z. S., 1856, p. 35; Monogr. Hel. Viv., iv, p. 668.—Blanford, Geol. and Zool. Abyss., p. 476.—*Pupoides sennariensis* Pfr., Ancey, Journ. de Conchyl., liii, 1905, p. 263 (Aden).—*Bulimus sennaaricus* Bourguignat, Hist. Malac. Abyssinie, 1883, p. 59.—*Leucochiloides sennaaricus* Pfr., Pallary, Mem. l'Inst. Egyptien, vi, 1909, p. 41, pl. 3, f. 12.

Differs from *P. cænopictus* chiefly by its smaller size; whether it is specifically distinct appears doubtful, as are also its relations to various Arabian forms. The type has not been figured, my figures being copied from Jickeli.

13*a*. *Bulimus cerealis* Paladilhe (pl. 13, fig. 7). — Shell rimate-perforate, rather long subovate, corneous-whitish or brownish, slightly striatulate; spire rather long conoid, apex somewhat obtuse. Whorls 6½, rather convex, rapidly increasing, parted by an impressed suture; last whorl a little larger than the penult, about ⅓ of the length at the aperture, strongly ascending at the insertion; free margin a little excavated, oblique. Aperture rounded-subovate, somewhat oblique; parietal margin usually unarmed, sometimes provided with a fold. Peristome simple, shortly reflected; outer margin a little arcuate, columellar dilated, reflected over the umbilical crevice. Length 4, diam. 2 mm. Aden (Issel). (*Bulimus cerealis* Paladilhe, Ann. Mus. Civ. Genova, iii. 1872, p. 16, pl. 1, f. 22, 23).

Considered by Bourguignat to be a synonym of *P. sennaariensis* (Pfr.).

13*b*. *Bulimus reboudi* Bgt. — Shell perforate, elongate-acuminate, subeonoid, subopaque, buff-corneous, obliquely striatulate. Spire elongate, acuminate, apex glossy, smooth, very obtuse, mamillate. Whorls 6, convex, regularly increasing, separated by an impressed suture, the last exactly one-third the length, rotund, ascending to the insertion of the lip. Aperture vertical, slightly lunate, rotund; peristome strong, flatly expanded and acutely reflected, margins strongly approaching, joined by a thin callus bearing a tooth at the insertion of the lip. Length 4, diam. 1¾ mm. Drift of the Oued-Roumana near Bousaada, that is, in the débris of the Oued which comes down from the Sahara of the province of Constantine [Algeria], where it was found by Dr. Reboud (*Bourguignat*, Species Novissimæ, 1876, p. 24).

Bourguignat should have indicated how this differs from *sennaariensis* if there is any difference except in locality.

13*c*. *Bulimus aethiopicus* Bourguignat. Pl. 14, figs. 3, 4.— "This Bulimus, remarkable for its deep umbilicus, relatively very open, is especially characterized by having the last whorl produced to the right, a little eccentric to the axis; the aperture is more rounded and the outer lip more convex than in *senaaricus;* the last whorl, noticeably subangular around the umbilicus, has a marked ascending direction above. The whorls, 6 in number, are less frankly convex, and the suture not so deep.

"Dr. Jickeli (Moll. N. O. Afr., pl. 5, f. 1 *d* and *e* only) has

given a quite good representation of this form under the name of *fallax*.

"The *æthiopicus* was collected by M. A. Raffray on the high plateaux of the Hamacen and Anderta as well as upon the col of Abouna Yousef, where it lives under stones and rubbish" (*Bgt.*).

Bulimus æthiopicus Bgt., Hist. Malacologique de l'Abyssinie, 1883, p. 62.

Jickeli's figures are copied. I cannot judge of the value of the characters noted as distinguishing this from *sennaarensis* having seen neither. In shape it appears to resemble the Arabian form described as *ragius* Jouss.

14. Pupoides fabianus (Gredler).

Shell oval-elongate with conically tapering spire, blunt at the apex, thin, strongly translucent, horn-yellow, with a fine silken luster; the 5 whorls are rather convex, superficially and irregularly striate, the last moderately large. Umbilical crevice distinct, a little oblique. Aperture large, oblique, oval, obliquely truncate by the parietal wall above. Peristome nearly right-angularly reflected, with a narrow white lip within, shortly and flatly expanding, sharp-edged; the inner margin not dilated, the outer margin arcuate, curved in at the insertion, a contiguous, rudimentary short fold on the parietal wall. Length 2, breadth 1⅓ lines (*Gredler*).

Africa: country of the Schilluck negroes (? Egyptian Soudan) (P. Fabian Pfeifer).

Buliminus fabianus Gredler, Nachrichtsblatt d. deutschen Malak. Ges., vii, Dec., 1875, p. 87.

It appears to be a wider and more delicate shell than *P. sennaariensis*. Has not been figured, and was not compared by its author with any other *Pupoides*.

(*East Africa.*)

These species, known to me only by the following descriptions, have not been compared with those of other regions. Preston's species were not compared with those of Taylor, or with *P. cœnopictus*.

15. Pupoides bawriensis (Taylor).

Shell ovate-conical, somewhat turrite, moderately strong, of a dark brown color and very finely striatulate transversely; epidermis moderate; whorls 5½ to 6, very convex, inflected towards suture, gradually increasing in size downwards—the penultimate and body whorls are both large, the latter, however, rather the larger; spire produced, apex rounded, small, suture distinct, mouth oval, longer than broad; peristome thickened, everted so as to form a broad flat margin presenting the appearance of a double peristome; umbilicus deep and distinct. Length, 0.175; breadth, 0.087 in. [about 4.37 x 2.17 mm.] (*Taylor*).

East Africa: a few dead specimens on Bawri Island, Zanzibar Channel. Appears to be peculiar to the island; it occurs in old shells among dead leaves (Gibbons).

Bulimus bawriensis Taylor, Journ. of Conch., iii, 1880, p. 142.

"The next two species form with this a section, in which are some Australian Bulimi. *B. pacificus* Pfr., from Queensland, appears almost exactly like the above species, but is probably distinct" (*Taylor*).

This species and the following need comparison with *P. sennaariensis*.

16. Pupoides zanguebaricus (Taylor).

Shell ovato-conical, inclining to turrite, moderately thick, of a light brown color, very faintly striatulate transversely; epidermis rather thin; whorls 6½, tumid, inflexed towards suture, gradually enlarging towards body whorl, which is the largest of all — the penultimate and preceding whorls are nearly equal in size; apex small and rounded; suture deep and distinct; mouth rotundo-ovate, nearly as broad as long; peristome thin, everted; inner lip short, reflected a little outwards behind; umbilicus small but deep and distinct. Length, 0.162; breadth, 0.075 [= about 4.05 x 1.78 mm.] (*Taylor*).

East Africa: Numerous dead among grass in a sandy spot down the coast of Zanzibar (Gibbons).

Bulimus zanguebaricus TAYLOR, The Journ. of Conch., iii, 1880, p. 143.

This is very closely allied to the last, but may be distinguished by its smaller and more slender shape, by being thinner, and by having the peristome less everted and solid.

17. PUPOIDES CHANLERENSIS Preston (pl. 14, fig. 6). "Shell small, rimate, cylindrically fusiform, slightly shining, reddish brown; whorls 5, regularly increasing, the last ascending in front, marked with oblique, transverse growth-lines; suture well impressed; umbilicus very narrow; columella curved, labrum rather narrowly expanded, whitish, not reflexed; aperture subcircular, bearing a single, nodulous denticle just below the point of insertion of the labrum with the parietal wall. Alt. nearly 4, diam. maj. 1.75 mm.; aperture: alt. .75, diam. nearly .75 mm.

Chanler Falls, Eusso Nyiro, British East Africa, Robin Kemp (*Leucochiloides chanlerensis, Preston,* Proc. Zool. Soc., 1912, p. 188, pl. 31, f. 16).

Compare *P. sennaariensis.* A topotype from Preston is drawn in pl. 17, fig. 4. It is a smaller, more delicate shell than *P. cœnopictus,* with the narrower lip but slightly thickened; possibly not fully mature. Length 4.1, diam. 1.8 mm.; 5½ whorls (B. Walker coll., no. 41592).

18. PUPOIDES GAZIENSIS (Preston). Pl. 14, fig. 8.

Shell small, ovately fusiform, pale reddish brown; whorls 5, convex, marked with fine, oblique, transverse striæ; suture deeply impressed, umbilical area broadly depressed; labrum with converging upper margin, white, rather broadly expanded; aperture ovate. Alt. nearly 4.5, diam. maj. 2.25, diam. min. 2 mm. Aperture alt. 1, diam. .5 mm. (*Preston*).

British East Africa: Gazi (Robin Kemp).

Leucochiloides gaziensis PRESTON, P. Z. S., London, 1912, p. 188, pl. 31, f. 19.

Compare *P. c. samavaensis.*

19. PUPOIDES CONSANGUINEUS (Preston). Pl. 14, fig. 9.

Shell differing from *L. gaziensis* Preston by its still smaller

size, narrower form, much more inflated whorls and consequently still more deeply impressed suture. Alt. 3.5, diam. maj. 1.5 mm.; aperture, alt. 0.75, diam. 0.25 mm. (*Leucochiloides consanguineus* Preston, Revue Zoologique Africaine, iii, fasc. 1, 1913, p. 52, pl. 4, f. 5).

British East Africa: Gazi (Robin Kemp).

(West Africa: Senegal and Cape Verde Islands to Southwest Africa.)

20. Pupoides cœnopictus senegalensis (Morelet). Pl. 13, figs. 13, 14.

Shell rimate-perforate, somewhat elongate conic, the apex rather obtuse; thin, a little glossy, brown, pellucid, under a lens very finely striate; whorls 6½, a little convex, the last a little compressed at base, not one-third the length. Aperture ample, oval, provided with a punctiform tooth at the insertion of the right lip; peristome expanded, thin, margins approximating. Length 6, diam. 2 mm. (*Morelet*).

Senegal: Island of Gorée, abundant under stones (type loc.). Bakel (Capt. Em. Dorr). Angola: Loanda and on the banks of Lake Quicuxe (Dr. Welwitsch).

Pupa senegalensis Morelet, Revue Zoologique, 1848, p. 354; Séries Conchyliologiques, i, p. 28, pl. 3, f. 4; Voyages du Dr. Welwitsch, p. 81 (Loanda).—Pfr., Monogr. Hel. Viv., iii, 534; iv, 665. — Pupoides senegalensis Morel., Kobelt, Conch. Cab., Buliminidæ, p. 922, pl. 130, f. 9, 10.—*Bulimus putillus* Shuttleworth, Mittheil. Bern., 1852, p. 295.—*Pupa putilla* Shuttl., Pfr., Monogr., iii, p. 533. — *Buliminus (Ena) cœnopictus* Hutton, Dautzenberg, Mém. Soc. Zool. France, iii, 1890, p. 129, pl. 1, f. 4*a*, 4*b* (Bakel).

This West African form is about intermediate between *cœnopictus* and *lardeus* in proportions, the spire almost straightly conic, the peristome broader and flatter than in typical *cœnopictus*, of which it should probably be considered a local race or subspecies, if indeed it is at all separable. A Gorée specimen measures: length 5.2, diam. 2.5, length of aperture 2.1 mm.; 6 whorls.

M. Dautzenberg (1890) considered *senegalensis* a synonym

of *cænopictus*, figuring the form from Bakel, which is more obese than the Gorée Island specimens. One of the Bakel lot received from Dautzenberg measures: length 5.15, diam. 2.8, length of aperture 2.45 mm.; 5⅔ whorls (pl. 13, fig. 14). As the *cænopictus* group has been split up elsewhere, these shells would be a distinct species, or perhaps referable to *lardeus* Pfr.; but I am inclined to believe that slender and more obese mutations may occur in all the local races.

Bulimus putillus Shuttleworth. — Shell rimate-perforate, fusiform-oblong, very finely obliquely striatulate, reddish, a little glossy. Spire long-conic, the apex obtuse. Whorls 6, convex, the last scarcely one-third the length. Aperture oval, slightly oblique, having a punctiform tubercle on the penult whorl near the junction of the right margin of the peristome; peristome broadly expanded, very much callously thickened, brownish, the right margin strongly curved. Length 5.5 to 6, diam. 2.25, aperture 1.5 mm. long. Very abundant on Gorée Island, Verreaux (*Shutt.*).

21. Pupoides gemmula (Benson).

Shell rimate-perforate, ovate-conic, striatulate, glossy, corneous. Spire conic, suture impressed, apex rather obtuse. Whorls 5, the last subangularly compressed at the base around the umbilicus. Aperture rounded-oval, provided with a scarcely noticeable subangular tubercle, peristome somewhat expanded throughout, thin, acute, the right margin arcuate. Length 2⅓, diam. 1⅓ mm. (*Benson*).

Length 3 to 4.5 mm. (*Dohrn.*).

Cape Verde Is.: S. Vicente (Layard); S. Antao, S. Vicente, S. Nicolao, S. Iago (Dohrn); Fogo and Brava (Wollaston).

Bulimus gemmula Bens., Ann. Mag. N. H. (2), xviii, 1856, p. 434.—Pfr., Monogr., iv, p. 415.—Wollaston, Testacea Atlantica, 1878, p. 508. — *Buliminus gemmula* Benson, Dohrn, Malak. Blätter, xvi, 1869, p. 10.—*Pupoides gemmula* Kobelt, Conchyl.-Cab., Buliminidæ, p. 970.

It differs from the nearly related *B. senegalensis* Morelet by the smaller size, compression of the whorls and the proportion of the last to the length of the shell, according to Dohrn, who found the dimensions to vary from 3 to 4½ mm. long.

Wollaston notes that it has the habit of coating itself over with a hardened envelope of dirt, and that the angular tubercle is as often absent as present.

22. Pupoides calaharicus (Bttg.). Pl. 14, figs. 10, 11; pl. 17, fig. 8.

In shape more like the Mexican *B. chordatus* P. than any of the species near *B. cœnopictus* Hutt. Shell small, widely rimate, cylindric-oblong, rather thin, corneous-brown, glossy; spire convexly turrited; apex rather obtuse. Whorls 5½ to 6, convex, very slowly increasing, not differing much in height, separated by an impressed, narrowly margined suture, obliquely, arcuately striate, the last slightly ascending, somewhat inflated, swollen around the rimation, anteriorly yellow, subconstricted, scarcely one-third of the length. Aperture truncate-oval, receding basally; columella deep, simple; peristome acute, flatly and widely expanded, whitish, margins converging, joined by a callus which bears a tubercle at the insertion of the right margin; right margin almost angularly curved above, the basal semicircular, columellar somewhat straightened, spreading. Length 5¾ to 6¼, greatest diam. 2¼ to 2⅝ mm.; alt. aperture 2, width 1⅝ to 1¾ mm. (*Bttg.*).

British Bechuanaland: Ghous (Nolte, type loc.). Griqualand West: Blaauwbosch Poort, Hay District (Day). Hartz River, Taungs (Miss Wilman). Damaraland (Geale, in British Mus.). Rhodesia: Victoria Falls (Connolly). Cape of Good Hope: Jansenville (Farquhar, Crawford); Prieska (Gibbons); Karroo (Brit. Mus.).

Buliminus (Leucochiloides) calaharicus Boettger, Bericht Senck. Nat. Ges., 1886, p. 24, pl. 2, f. 3*a-c*. — *Leucochiloides calaharicus* Boettger, Connolly, Ann. S. Afr. Mus., xi, pt. 3, 1912, p. 177.

"Of this species three specimens were found in the same locality as *Hx. alexandri* P., f. *minor*, at Ghous in the southern Kalahari. One of them was collected alive. The species appears to harbor by preference in the old shells of the *Helix*.

"Compared with the *Leucochiloides* species *B. fallax* Say, *cœnopictus* Hutton, *conspectus* Hutton, *fabianus* Gredler, *senegalensis* Morelet, *sennaaricnsis* P., *acthiopicus* Bgt. and

nitidulus P., all of which I could compare in my collection, the present species is the most cylindric of all, being longer and more cylindric than *B. conspectus* Hutt., and its whorls increase so slowly that the three last differ but little in height'' (Bttg.).

''*B. conspectus* Hutton'', mentioned by Boettger, is apparently a label error for *cœnopictus,* as Hutton did not describe any *conspectus.*

Possibly the specimens reported from Jansonville are the same as those which I have referred to *cœnopictus.* Boettger's original figures are copied by photography in pl. 14, figs. 10, 11.

A series from Swakop Valley in the S. W. African Protectorate, sent by Mr. Burnup, show a somewhat less cylindric form than Boettger's figures, though they are more so than *P. cœnopictus.* They differ very little from the narrower examples of *P. senegalensis.* One measures: length 5.4, diam. 2.6 mm. (pl. 17, fig. 8).

23. Pupoides minusculus (Mousson). Pl. 14, fig. 5.

Shell minute, rimate-perforate, elongate-ovate, without gloss, brownish-corneous. Spire convexly conic, regular, the summit somewhat obtuse; suture moderately impressed. Whorls 5, quite convex, the last $\frac{2}{5}$ the length, oval, rotund, little ascending, a little compressed about the rimation. Aperture nearly vertical, lunate-oval; peristome acute, white, narrowly reflected, margins little approaching, joined by a thin layer which has a grain above at the insertion; right margin less, basal more curved; columellar spreading, the columella deep within. Length 3, diam. 1.8 mm. Ratio of whorls 2:1; ratio aperture 3:2 (*Mousson*).

South Africa. Ovampoland: Ku-Ganab, southeast of Ondonga (Schinz); Hoeis (Hermann); Sodanna (Passarge). Bechuanaland: Meno a kwena, fossil (Passarge).

Buliminus (Leucochiloides) minusculus Mouss., Journ. de Conchyl., 1887, p. 295, pl. 12, f. 5, 5*a*.—v. Martens, Die Kalahari, 1904, p. 754. — *Leucochiloides minusculus* (Mouss.), Boettger, Abh. Senck. Nat. Ges., xxxii, 1910, p. 445.—Connolly, Ann. S. Afr. Mus., xi, 1912, p. 177.

According to Mousson this species is less cylindric than *calaharicus*. Aside from the size, it resembles *Pupa senegalensis* Morelet, but the whorls are less convex, the form less elongate, the shell more delicate, the margins of the aperture less reflected, finally the size is notably smaller. I have not seen specimens.

Dr. Boettger reports it from Hoeis, dead shells taken by Dr. P. Hermann. They are somewhat larger, alt. 3¾ to 4¼, diam. 2 mm., 5½ whorls.

III. Australian Species.

In this series the angular tubercle is somewhat more united with the lip-insertion than in Asiatic or African species, but it is more distinctly developed and less united than is usual in the American. While the species show considerable variety of size and form, they appear to be closely inter-related, and presumably of common ancestry.

The author is indebted to the late Professor Ralph Tate and to Charles Hedley for many specimens.

1. Shell dextral ..... 2.
   Shell sinistral ..... 4.
2. Solid, partly whitish, the later whorls somewhat flattened; 5.5 to 6.35 mm. long; South Australia.
   P. adelaidæ, no. 24.
   Rather thin, brown or corneous-brown, whorls convex; 3.7 to 5.5 mm. long ..... 3.
3. Central Australian desert region. *P. c. beltianus*, no. 26*a*.
   West, north and east coastal regions. *P. pacificus*, no. 25.
4. Conic-turrite, 4.5 x 2 to 5.65 x 2.7 mm. *P. contrarius*, no. 26.
   More slender, cylindric-turrited ..... 5.
5. Head of the Great Australian Bight; 4.5 x 1.5 mm.
   P. myoporinæ, no. 27.
   Central Australia; 4 to 4.5 x 1.7 mm. *P. ischnus*, no. 28.

24. Pupoides adelaidæ (Ad. & Ang.). Pl. 15, figs. 1, 2.

Shell turrited, pupiform, dilated in the middle, umbilicate, whitish-bay; whorls 6, convex, longitudinally streaked (*stri-*

gillatis). Aperture rotund-ovate, peristome interrupted, white, widely reflected; outer lip having a tuberculiform white callus above. Length 3, width 1 line [about 6:2 mm.] (*A. & A.*).

South Australia, rocky places (Angas); Flinders Range, Rapid Bay and Wallaroo (Masters). Point Lowly, head of Spencer Gulf (Cox, *P. ramsayi*); Port Lincoln (A. N. S. P.). Wombo, near Singleton, N. S. Wales, rather more elongated than the type (Brazier).

Buliminus (Chondrula) adelaidæ A. Adams & G. F. Angas, Proc. Zool. Soc. London, 1863, p. 522.—*Bulimus adelaidæ* A. & A., Cox, Monogr., Australian Land Shells, 1868, p. 69, pl. 13, f. 5. — Brazier, P. Z. S., 1872, p. 807. — Pfr., Monogr., vi, p. 74. — *Pupa ramsayi* Cox, Catal. Australian Land Shells, 1864, p. 28; Ann. Mag. N. H. (3), xiv, p. 184.

Much larger and more cretaceous than other Australian species. It has the appearance of a desert snail.

The shell is solid, rather opaque, cream-buff with whitish streaks, a little browner towards the summit, whiter on the last whorl, or the last two or three whorls may be nearly white. The penult whorl is as wide as the last; above that it tapers rapidly to the small, somewhat obtuse, glossy apex. The later whorls are somewhat flattened, the last slowly ascending in front, saccate basally. The striation is distinct, irregular. The ovate aperture has a narrowly reflected, internally thickened peristome, the columellar margin dilated, insertions widely separated. A small angular tubercle is more or less joined to the lip-insertion.

Length 6.35, diam. 2.6 mm.; 6 whorls. Port Lincoln.

Length 5.6, diam. 2.45 mm.; 5½ whorls. Port Lincoln.

Pupa ramsayi Cox was subsequently placed by him in the synonymy of *adelaidæ*, and came from the same district. Its length was given as 0.2 inch, about 5 mm.

25. Pupoides pacificus (Pfr.). Pl. 15, figs. 11 to 15.

Shell deeply rimate, ovate-cylindric, the apex rather obtuse; somewhat solid, smoothish, brown-corneous. Whorls 5½, convex, the last about one-third the total length. Aper-

ture semioval, toothless; peristome narrowly expanded, white-lipped within, the right margin shortly curved above, sometimes with a contiguous callous tubercle; columellar margin wider, spreading. Length 4⅓, diam. 2⅓, aperture 1⅓ mm. long (*Pfr.*).

Australia: Narrabri, N. S. Wales, the coastal plain and islands of Queensland and Torres Strait; West and Northwest Australian coast and islands.

Pupa pacifica Pfeiffer, Proc. Zool. Soc., 1846, p. 31; Monogr. Hel. Viv., ii, 309; iii, 532; Conchylien-Cabinet, *Pupa*, p. 163, pl. 19, f. 26-28.—Hedley & Musson, Proc. Linn. Soc. N. S. Wales (2), vi, 1892, p. 558.—E. A. Smith, Proc. Malac. Soc. Lond., i, 1894, p. 96.—*Bulimus pacificus* Pfr., Monogr., iv, 414.—Cox, Mon. Australian Land Shells, 1868, p. 68, pl. 13, f. 3.—Brazier, Journal of Conch., i, p. 272; Proc. Linn. Soc. N. S. W., i, 1877, p. 127.—E. A. Smith, Zool. Voy. Erebus and Terror, 1875, Mollusca, p. 3, pl. 4, f. 8 (Pigeon Is.).—*Buliminus fallax* Say, Hedley, Proc. Roy. Soc. Queensl., v, 1888, p. 64.—*Pupoides pacificus* (Pfr.) Pilsbry, Proc. A. N. S. Phila., 1900, p. 426, f. 1 (Facing I.).—*Buliminus (Chondrula) lepidula* Adams & Angas, Proc. Zool. Soc. Lond., 1864, p. 38.—*Bulimus lepidula* Ad. and Ang., Cox, Mon. Australian Land Shells, 1868, p. 69, pl. 19, f. 14*a*, *b*.

The color varies from chestnut-brown to a pale, almost "corneous" tint. It is usually transparent enough to see the axis or the dried animal faintly through, though some are nearly opaque. In its upper third the outer lip is more curved and decidedly narrower; below that it is more widely reflected, with a well-developed callous rib within. The specimens from Mapoon, on the Gulf of Carpenteria, and from Forrest River, West Australia, have the lip narrower than those seen from the east coast. If this proves constant they might be separated as a race *lepidula*.

P. beltiana Tate is more elongate than *P. pacifica*, but in some specimens the difference is not great.

The angular lamella forms a shortly entering tubercle, and is always present in adult shells, so far as seen.

In most of the lots examined the shape varies from regu-

larly tapering to more elongate contour with the penult whorl relatively larger.

Length 5.2, diam. 2.45, aperture 1.75 mm.; 5¾ whorls. Narrabri.

Length 4.4, diam. 2.35, aperture 1.7 mm.; 5½ whorls. Narrabri.

Length 4.4, diam. 2.2, aperture 1.55 mm.; 5½ whorls. Narrabri.

Length 4.8, diam. 2.4, aperture 1.75 mm.; 5½ whorls. Forrest R.

Length 4.25, diam. 2.25, aperture 1.65 mm.; 5⅓ whorls. Facing Is.

While there are very considerable sections still without records of *Pupoides,* it appears likely that this species will be found throughout the coastal regions from West Australia around the northern coast and to beyond the southern border of Queensland. The records of distribution follow.

New South Wales: Narrabri! (C. T. Musson; pl. 15, figs. 12, 13).

Queensland: Rodd's Bay, Facing Island!, Gracemere, Bogantungan, Calliungal, Torsdale, Cania, Kroombit, Banban, Gympie and North Pine River (C. T. Musson). Moreton Bay! (W. P. Wilstach in A. N. S.). Brisbane, Ipswich, Port Curtis, etc., along the coasts and islands of Queensland to Cape York and the islands of Torres Strait (MacGillivray, in Cox). Barrow, Fitzroy and Home Islands and Cape Grenville, northeast coast; Sue, Warrior, Bet, Long, Dungeness and Cocoanut Is., Torres Straits; Cape York and Albany Island, N. Australia (Brazier); Mabuiag, Torres Straits (Haddon, acc. to Smith). Sir Charles Hardy's Island, off Cape Grenville (Tucker, type loc.). Mapoon, entrance of the Batavia River, Gulf of Carpenteria! (Charles Hedley; pl. 15, fig. 15).

West and Northwest Australia: Pigeon Island, near Wallaby Island, Houtman's Abrolhos, W. Australia (Dr. Richardson, Smith); Roebuck Bay, Baudin and Cassini Islands, Northwest Australia (Walker, in Smith). Forrest River, East Kimberly district! (Richard Helms; pl. 15, fig. 14).

Form *sinistralis*.—"All the specimens from Cassini Island are sinistral; otherwise they resemble the normal form" (*E. A. Smith*). In over 100 specimens of *pacificus* from seven other localities, none were found sinistral.

Buliminus (Chondrula) lepidula of Adams and Angas has not been recognized by Australian conchologists of the last fifty years. It came from well within the known range of *P. pacificus*, and is, I cannot doubt, a synonym of that widespread species. The description follows:

Shell turrited, pupiform, umbilicate, thin, glossy, semipellucid, corneous; whorls 5, strongly convex, longitudinally striate. Aperture rotund-ovate; peristome interrupted, white, broadly reflected; outer lip provided above with a small, white, tuberculiform callus. Length 2, width 1 line [about 4:2 mm.] (*Adams and Angas*).

West Australia: Sharks Bay.

This little species differs from *C. adelaidæ* in being more semipellucid, shining and of a horn-color. The whorls, moreover, are much more strongly convex (*A. & A.*).

26. PUPOIDES CONTRARIUS (E. A. Smith). Pl. 15, figs. 9, 10.

Shell sinistral, rimate, brown-corneous, obliquely delicately striate. Whorls 5½, convex, separated by a deep suture, the last slightly wider than the penult, ascending in front. Spire long, convex, pyramidal, subglobose at apex. Aperture about ⅓ the total length; peristome white, expanded, margins joined by a thin callus bearing a tubercle at the insertion of the lip. Length 4.5, diam. 2 mm., aperture 1.5 mm. long (*Smith*).

West Australia: East Wallaby Island, Houtman's Abrolhos (Walker). Central Australia: widely distributed in the Larapintine area, extending to Hart Range, southerly beyond the Larapintine area to the Cretaceous hills about Sullivan Creek.

Pupa contraria SMITH, Proc. Malac. Soc. London, i, 1894, p. 96.—TATE, Report Horn Sci. Exped. to Central Australia, ii, Zoology, 1896, p. 204, pl. 19, f. 17.—*Pupa eremicola* TATE. Trans. Roy. Soc. S. Australia, xviii, 1894, p. 191.

The typical form, from Houtman's Abrolhos, off the west coast, has not been figured; but the shell described by Tate as *P. eremicola* was considered the same by E. A. Smith. It is a somewhat larger race (pl. 15, figs. 9, 10). Three of the original lot received from Tate measure:

Length 5.65, diam. 2.7, length aperture 2.1 mm.; 5¾ whorls.

Length 5.45, diam. 2.8, length aperture 2.13 mm.; 5¾ whorls.

Length 5.45, diam. 2.55, length aperture 2 mm.; 5½ whorls.

26*a*. P. CONTRARIUS BELTIANUS (Tate). Pl. 15, figs. 5, 7, 8.

"A longer and narrower shell than *P. pacifica*, with less convex whorls; rarely sinistral. Length 4.5, width scarcely 2 mm.; a more slender form 4.5 x 1.5" (*Tate*).

Length 5.5, diam. 2.5, length aperture 2.15 mm.; 6 whorls.

Length 4.75, diam. 2.15, length aperture 1.75 mm.; 5½ whorls. Fig. 8.

Length 3.7, diam. 1.8, length aperture 1.5 mm.; 4⅔ whorls. Fig. 7.

Central Australia; specific localities not given (Horn Exped.).

Pupa beltiana TATE, Trans. Roy. Soc. South Australia, xviii, 1894, p. 191.—*Pupa contraria*, dextral form, TATE, Rep. Horn Sci. Exped. Central Australia, ii, Zoology, 1896, pp. 204, 219, pl. 18, f. 15*a*, *b*.

Two lots of this form received from Professor Tate show wide variation in size, but no sinistral shells were included. When fresh it has the usual cinnamon-brown color of the group, is glossy, with slight, irregular striation. The angular lamella is an elongate tubercle united with the lip insertion. The moderately wide lip is thickened within. The diameter at the penult whorl is nearly or quite equal to that of the last whorl above the aperture.

From the specimens seen I would consider this specifically distinct from *P. contrarius eremicola;* but it is left associated with *contrarius* in deference to the opinions of Smith and Tate.

27. PUPOIDES MYOPORINÆ (Tate). Pl. 15, fig. 6.

Shell sinistral, umbilicated, oblong-turreted, very thin, translucent, yellowish horn-colored, showing under the lens regular fine transverse striæ. Spire elongated, gradually tapering, rather acute; whorls five, moderately convex, last whorl equaling one-third the total length of the shell. Aperture somewhat ovate; peristome white, expanded, especially the columella margin; left margin with a white tooth-like callosity in the angle. Length .18, breadth .06 inch [about 4.5 x 1.5 mm.] (*Tate*).

South Australia: Under small bushes on the sandy margin of the salt swamp at Peelunibie, head of the Great Australian Bight, 50 examples observed.

Bulimus sinistrorsus TATE, Trans. and Proc. and Rep. Philos. Soc. Adelaide, South Australia, 1879, p. 134, pl. 5, f. 4. Not of Deshayes.—*Bulimus myoporinæ* TATE, Trans. and Proc. and Rep. Royal Soc. South Australia, iii, 1880, p. 104, n. n. for *B. sinistrorsus*.

Tate's description and figure are copied. "The name has reference to the habitat of the snail, that of living under the shelter of *Myoporum parvifolium*."

28. PUPOIDES ISCHNUS (Tate). Pl. 15, figs. 3, 4.

Shell pyramidally oval, thin, translucent, shining, yellowish-brown, apex obtuse, whorls five and a half, moderately convex, separated by an impressed suture, finely obliquely striated. Aperture sinistral, oval, truncated behind, peristome white, broadly reflected, especially over the columella, which does not conceal a narrow umbilical fissure; the lips are callously united and there is a prominent tubercle at the insertion of the outer lip. Length 4.25, width 1.25 mm. (*Tate*).

Central Australia: Alice Springs and Palm Creek (Horn Exped.).

Pupa ichna TATE, Trans. Roy. Soc. S. Australia, xviii, 1894, p. 191; Rep. Horn Sci. Exped., ii, Zool., 1896, p. 204, pl. 19, f. 16.

"A more slender shell and more attenuate apically than *P. contraria;* in its sinistral spire and apertural characters it

agrees with *P. myoporinæ* Tate, which is possibly only a sinistral form of *P. pacifica*, from which it differs in its narrow elongate shape and flatter whorls. It may prove on comparison of actual specimens conspecific with *Chondrula lepidula* Ad. and Ang." (*Tate*).

This narrow, sinistral species seems quite distinct from all others except *P. myoporinæ*, which I have not seen. Specimens from Palm Creek, which may be taken as the type locality, measure:

Length 4.45, diam. 1.7, aperture 1.57 mm.; 5¾ whorls.

Length 4, diam. 1.7, aperture 1.3 mm.; 5½ whorls.

Genus MICROSTELE Boettger.

Microstele Bttg., Bericht Senckenb. Nat. Ges., 1886, pp. 25, 26. Type by orig. designation *Pupa noltei*.

Shell small (3¼ to 4½ mm.), rimate, turrited, with obtuse apex, of (5½ to 6) strongly convex whorls. Aperture ovate, with reflected, internally thickened lip, terminations remote; a small angular tubercle, deeply placed parietal and columellar lamellæ and sometimes one or two immersed palatal tubercles.

Distribution, India and Ceylon, East and Southwest Africa; Miocene of Europe.

With the shape of shell and aperture like *Pupoides*, this genus has teeth like *Pupilla*. In many genera of Pupillidæ there are species with and others without teeth; but *Microstele* is here considered generically distinct because *Pupoides*, in all the continents, is remarkably uniform in characters of the aperture.

It may be inferred that the *Microstele* species are surviving representatives of the ancestral stock which gave birth to *Pupoides*.

Two species from the Miocene of Europe are rather closely related to *M. muscerda* of Ceylon.

Microstele wenzi (K. Fischer). *Pupoides wenzi* K. Fischer, Archiv f. Molluskenkunde, lii, 1920, p. 92, fig. 1. Wenz, Senckenbergiana, ii, June, 1920, p. 112, fig. 2. Upper

Miocene landshell marl, Palm Garden, Frankfurt a. M.; also Voeslau, Vienna Basin, in marine sands.

MICROSTELE MARLÆ (de Morgan). *Pupa (Pupilla) mariæ* J. de Morgan, Bull. Soc. Geol. de France (4), xix, 1919, no. 9, p. 315, fig. 10 (November, 1920). Faluns de Touraine: Pont-Levoy (sablière du vallon de Charenton). Near the preceding but a little smaller, the palatal fold vestigeal, angular lamella strongly developed. This bed is about synchronous with Sansan.

1. MICROSTELE MUSCERDA (Bens.). Pl. 14, figs. 19, 20.

Shell rimate, ovate-oblong, striatulate, corneous; spire long, apex obtuse; whorls 5½ to 6, a little convex, the last one-third the length of the shell, slightly ascending. Aperture ovate, three-toothed; peristome expanded, acute, the margins converging, columellar margin dilated, whitish; one parietal fold, one columellar, rather deeply placed, one depressed, obtuse palatal tooth. Length 4, diam. 1.5 mm. (*Bens.*).

Ceylon: Cape Pedro, in old posts and on palmyra trees, Borassus flabelliformis (Layard, type loc.); Baticalva (Preston); Jaffna (Linter). India: Erode (Beddome).

Pupa muscerda BENSON, Ann. Mag. N. H. (2), xii, August 1853, p. 94.—PFR., Monogr. Hel. Viv., iv, p. 680.—HANLEY & THEOBALD, Conch. Indica, 1876, pl. 160, f. 2. — SOWERBY, Conch. Icon., xx, *Pupa*, pl. 7, f. 56.—*Pupilla muscerda* Benson, GUDE, Fauna Brit. India, Moll., ii, 1914, p. 286.

There is an angular tubercle or callus, not mentioned by Benson. The parietal lamella is high, short and deep within; the palatal fold is tubercular, visible in a front view. A considerable series shows this species to be rather constant in form and teeth. Length 4.15, diam. 1.95, aperture 1.47 mm.; 5½ whorls, or a little smaller, length 3.6 mm.

2. MICROSTELE IREDALEI (Preston). Pl. 14, fig. 18.

Shell differing from *L. chanlerensis* in its blunter form, more swollen whorls, deeper suture, more open umbilicus, straighter columella, and narrower and more erect labrum;

moreover, it lacks the nodulous denticle which in the present species is replaced by an erect white denticle situate low down on the parietal wall well within the aperture, and a smaller erect squarish denticle on the columella, also situate well within the opening. Alt. 3.5, diam. maj. 1.75 mm.; aperture: alt. .75, diam. nearly .75 mm. (*Preston*).

British East Africa: Eusso Nyiro (Robin Kemp).

Leucochiloides iredalei PRESTON, Proc. Zool. Soc. London, 1912, p. 188, pl. 31, f. 18.

No palatal tooth is present in this species. Preston's figure is reproduced in pl. 14, fig. 18. The aperture of a topotype, no. 41593 B. Walker coll., is drawn in pl. 17, fig. 7. Both parietal and columellar lamellæ are well developed. the former straight and entering rather deeply. There is also a distinct though small and rather short angular lamella. It is deeply rimate and narrowly perforate.

I have not been able to compare *M. oblonga* Bttg., which appears nearly related.

3. MICROSTELE OBLONGA (Boettger). Pl. 14, fig. 17.

Differs from *L. (Microstele) noltei* (Bttg.), which is near, by the somewhat smaller shell, perforate, oblong-fusiform, of a bay color, the spire convexly oblong. Whorls 5½, more convex, separated by a more impressed suture, the last equalling one-third the alt. of the shell. Aperture 3-toothed, the angular tubercle more distinct, parietal tooth pliciform, not so high, columellar strong, palatals wanting; margins of the peristome connected by a more distinct callus. Alt. 3¼, diam. 1½ mm.; aperture alt. and width 1 mm. (*Bttg.*).

Southwest Africa, Damaraland: 140 km. inward from the mouth of the Swakop, in southwestern Hereroland, one living specimen collected by Dr. Franz Rintelen, Boettger collection.

Leucochiloides (Microstele) oblongus BTTG., Abhandl. Senckenb. Nat. Ges., xxxii, 1910, p. 445, pl. 28, f. 11*a, b*.

It is with a certain reserve that I make this form a species distinct from *L. (M.) noltei*. My decision was taken from the diverse oblong-fusiform instead of cylindric-turrited shape, which is conspicuously shorter and more compressed,

and the lack of the two deeply-seated palatal folds. The difficulty of a positive decision was enhanced by the paucity of material—only one example of each form—and I would not reproach anyone for taking the snail under consideration for a local race of *L. noltei* (*Bttg.*).

4. MICROSTELE NOLTEI (Bttg.). Pl. 14, figs. 12 to 16.

Shell small, punctate-rimate, cylindric-turrited, solid, corneous-buff. Spire long, turrited; apex very obtuse. Whorls 6, very slowly increasing, rather convex, separated by a deep suture, lightly obliquely striatulate, the last scarcely larger than the penult, ¼ the length of the shell, angular at base, towards the aperture ascending a little, whitish, the back distinctly flattened and swollen around the rimation. Aperture small, circular-oval, the base a little receding, 4-toothed. Peristome acute, flatly and broadly expanded, white, the margins converging, joined by a callus which bears a tubercle at the insertion of the right margin; right margin is angularly curved above, the basal and left regularly arcuate. Teeth 4, deeply placed, 1 pliciform parietal, 1 strong columellar, twin palatals in the throat. Length 3.75, greatest diam. 1.5 mm.; aperture 1 mm. high and wide (*Bttg.*).

Southwest Africa, British Bechuanaland: Ghous, in the southern Kalahari (C. Nolte).

Pupa (*Microstele* n. sect.) *noltei* BOETTGER, Bericht Senckenb. Nat. Ges., 1886, p. 25, pl. 2, f. 4*a-c*. — MELVILL & PONSONBY, Ann. Mag. N. H. (8), i, 1908, p. 78, pl. 2, f. 14, 15 (copied from Boettger). — *Leucochiloides (Microstele) noltei* BTTG., Abh. Senck. Nat. Ges., xxxii, 1910, p. 445.—CONNOLLY, Ann. S. Afr. Mus., xi, 1912, p. 178.

Two specimens from near Klip (Connolly coll.) are figured. The larger (fig. 13) measures: length 4.5, diam. 1.5, length aperture 1.2 mm., fully 7 whorls. It has only a weak trace of the angular tubercle. The parietal lamella is deeply placed and short. The twin palatal tubercles are connected basally, and not visible in a direct front view.

The smaller specimen (pl. 14, figs. 12, 16) measures: length 3.83, diam. 1.5, aperture 1.16 mm., 6¼ whorls. The spire is

somewhat stouter, whorls shorter. The angular lamella is strongly developed. Parietal lamella much longer and higher.

Connolly (*in litt.*) notes that "in a series of 18 shells of *noltei* from Klip, the largest, 3¾ x 1½ mm., contains six whorls and almost exactly matches Boettger's figure and description. The shells, however, vary in size and form, another example, 3½ x 1¼ mm., being more conical, less cylindrical, and coming very near indeed to his figure of *oblongus,* having, as Boettger says, more convex whorls and consequently deeper suture. All these 18 specimens appear to possess the *two* internal palatal teeth of *noltei,* but these are often extremely small and it would be easy to overlook them."

Genus MICROCERION Dall.

Microcerion Dall, Bull. 90, U. S. Nat Mus., 1915, p. 29, type *M. floridanum* Dall.

"Shell small, solid, few whorled, with one parietal and one pillar tooth, a nodulous parietal callus uniting the lips, a thickened duplex peritreme, both edges sharp, the posterior sharply reflected backward, the inner or anterior projecting forward, externally beveled to meet the bottom of the sinus between the two lips.

"This little shell stands about midway between *Cerion* proper and the small Pupidæ. Nothing exactly corresponding to it is known from other formations or from the recent fauna" (*Dall*).

Microcerion floridanum Dall (pl. 11, figs. 16, 17). Op. cit., p. 29, pl. 1, f. 16, 17. Oligocene, Orthaulax pugnax zone, Ballast Point, Tampa Bay, Florida.

The shell is 4.75 mm. long, of about 5 whorls. The peristome and solidity are features like *Cerion,* but the size, shape, and small number of whorls evidently indicate more affinity to *Pupillidæ.* It is perhaps a phylogerontic branch of the Pupillinæ, near *Pupoides* and especially *Microstele,* which appears to stand in an ancestral relation to *Pupoides.*

Genus PUPILLA Leach.

Pupilla Leach in TURTON, Man. Land and Freshwater Shells of the British Islands, 1831, p. 99. — GRAY, P. Z. S., 1847, p. 176 (type *P. muscorum*).—HERRMANNSEN, Ind. Gen. Malac., ii, p. 362 (*typus: Pupa muscorum* L.).—COCKERELL, Nautilus, xviii, 1905, p. 104.—*Torquatella* HELD, Isis, 1837, p. 919, for *P. muscorum* L. and *P. triplicata* Studer. — HERRMANNSEN, Ind. Gen. Malac., ii, p. 583, "typus *P. muscorum* L."—*Pupa* of most authors.

The shell is cylindric with rounded, obtuse ends, rimate and often perforate, of short, slowly increasing whorls, the sutures but slightly oblique. The small aperture has 0-5 teeth, the parietal, columellar and palatals deeply placed when present; no basal fold and no teeth in immature stages. Peristome reflected narrowly. Shell axis small, perforate.

The foot is about half as long as the shell, skin nearly smooth. Inferior tentacles short but distinct. Shell carried with the spire slanting upward a little. Some species at least are ovoviviparous.

Type: *P. muscorum* (L.). Distribution: North America, Eurasia, Africa, Australia, almost wholly in temperate and cold regions. They are ground snails, living under wood and stones and among leaves in moderately humid situations.

Pupilla is a widely distributed group, nowhere numerous in species, but generally abundant in individuals. The species are among the most variable of their family in size, color, the number and size of teeth and development of an external crest—features usually serving for specific definition. Albino shells are not uncommon; sometimes they form a considerable part of the colony. Shortness is a more frequent variation in nearly all species which have been collected in quantity. Whether this quality is an inherited strain or due to early formation of a lip in individuals born late in the season has not been ascertained, as no breeding experiment has been carried out. It is clear, however, that some colonies of *P. muscorum* comprise short and long shells, and those with one, two, or with no teeth, and are doubtless hybrid complexes. Similar conditions are found in some other species.

Classification.—The Pupillæ divide into four sections (the first three new), characterized thus:

a. Embryonic shell rather coarsely reticulate-granose; the rest regularly rib-striate.

Section *Striopupilla*, type *P. sterkiana*.

a[1]. Embryonic sculpture minute; striation elsewhere faint or weak.

b. Whorls increasing rather rapidly in height; spire convexly tapering from the last whorl, which is widest. Section *Afripupilla*, type *P. tetrodus*.

b[1]. Whorls increasing slowly; shell cylindric with short, convexly-conic summit.

c. Aperture having 2 to 5 teeth, an angular tubercle often present; apical whorls pitted-reticulate.

Section *Primipupilla*, type *P. signata*.

c[1]. Aperture having 0 to 3, rarely 4 teeth, no angular tubercle; apical whorls most minutely granulose.

Section *Pupilla* proper, type *P. muscorum*.

The geographic relations of these sectional groups may be represented thus:

Europe	*Asia*	*America*
Pupilla	Pupilla	Pupilla
Primipupilla	Primipupilla	Striopupilla
|	|	
Primipupilla	Primipupilla	
Afripupilla		
Africa	*Australia*	

The species are described under geographic groups:

I. North America: species 1 to 6.
II. Europe, North Africa: species 7 to 15, 21.
III. Asia: species 7, 13, 16 to 20, 22 to 29.
IV. Africa, Cape Verde Islands, Réunion I.: species 30 to 32.

V. Australia: species 33 to 35.
VI. Tertiary fossils: species 36 to 51.

Palæontology. — *Pupilla* appeared in the Upper Oligocene of central Europe, and in the Miocene became somewhat numerous. The species are referable to the section *Primipupilla*, and resemble the African group of *P. fontana*. A few Miocene forms are sinistral (*P. blainvilleana, P. steinheimensis*). Forms such as *P. perlabiata*, more like recent species of northern China, are from the Upper Miocene.

Early species of the typical section of *Pupilla*, the *muscorum* group, have been found in German Upper Miocene. The teeth are somewhat well developed, as in the recent *P. triplicata*. A list of fossil species follows the account of recent forms.

In the absence of Eocene representatives in western Europe it appears likely that the origin and early development of the genus took place in Asia, whence in the middle Tertiary or earlier, Africa and Australia received their *Primipupillæ*. In America *P. sterkiana* stands isolated and cannot be traced, but the other Pupillæ appear like recent immigrants, not earlier than Pliocene, the northern *P. muscorum* later. Only the section *Pupilla*, a group adapted to humid, cool-temperate regions, reached this continent, and they retain the closest resemblance to Old World species. *P. blandi* and especially *sonorana* stand close to the Alpine *P. triplicata*. *P. hebes* resembles the European *cupa* and *alpicola*. Finally, *P. muscorum* in New England and Canada is indistinguishable from those of northern Europe. The Rocky Mountain and loess *muscorum* may perhaps be older immigrants.

I. North American Species.

While the American species of *Pupilla* appear distinct enough from one another typically, they vary remarkably in teeth, crest and size, so that the identity of a particular lot is sometimes in doubt. The key to species cannot be trusted implicitly. Thus, there are intermediate forms between *sonorana* and *blandii*, and the *pithodes* form of *blandii* has

much in common with *hebes*. *P. muscorum* is sometimes thin-lipped, closely approaching *hebes*. *P. hebes* and *P. syngenes* occur in both dextral and sinistral forms. Colonies containing albinos have been noted in *muscorum*, *syngenes*, *hebes* and *blandii*. They form an intricate complex of races, the affinities of which may be represented by a diagram.

sonorana—blandii—muscorum—syngenes
| |
pithodes—hebes

P. sterkiana stands apart from this complex of forms, being strongly characterized by the sculpture of both embryonic and later whorls, the former resembling those of *Primipupilla*.

Key to American Species.

1. Shell rib-striate, the embryonic whorls reticulate-granose; Lower California (Section *Striopupilla*).
P. sterkiana, no. 1.
Shell minutely striate or smoothish (Section *Pupilla* proper) ..... 2.
2. Spire slightly wider above than below; parietal lamella long; 8-10 whorls. .....*P. syngenes*, no. 6.
Spire not wider above; whorls less numerous ..... 3.
3. Aperture having three well-developed teeth, the palatal fold somewhat long ..... 4.
Teeth wanting or, when present, small, the palatal fold tubercular ..... 5.
4. Length 3.2 to 3.75 mm. .....*P. blandi*, no. 3.
Length 2.5 to 3.25 mm.; palatal fold long; last whorl much flattened behind the crest. .....*P. sonorana*, no. 4.
5. Lip typically *thickened within*, with a whitish crest externally; teeth small or wanting.....*P. muscorum*, no. 2.
Lip thin; crest colored like the shell, often low, scarcely noticeable; typically toothless; Arizona to Idaho.
P. hebes, no. 5.

1. PUPILLA STERKIANA (Pilsbry). Pl. 19, figs. 16, 17.

The shell is cylindric with short, rounded summit and obtuse apex; rimate and minutely perforate; cinnamon-brown. The surface is dull; the embryonic 1½ whorls coarsely, irregularly reticulate-granulose, following whorls having *narrow, strongly retractive axial riblets*, about one-fourth as wide as the intervals. The whorls are strongly convex, suture deep, the last whorl somewhat compressed laterally, without crest or noticeable contraction behind the lip. The aperture is somewhat oblique, squarish. Peristome expanded, thickened and whitish on the face and within, narrow and abruptly bent near the posterior insertion; margins connected by a short, whitish, adnate callus. In oblique view in the aperture the columella appears weakly subtruncate below, or in some specimens there is a distinct tooth (fig. 16).

Length 4.5, diam. 1.6 mm.; 7⅓ whorls.

Length 3.8, diam. 1.65 mm.; 6⅔ whorls.

Lower California: San Ramon (C. R. Orcutt).

Pupa sterkiana PILS., Proc. A. N. S. Phila., 1889, p. 411, pl. 2, f. 2, 3.

This species differs conspicuously from all other known Pupillæ by the sculpture of both embryonic and later whorls.

2. PUPILLA MUSCORUM (L.). Pl. 18, figs. 12 to 16.

Description on page 173. American specimens rarely have the lip so much thickened or the white or yellowish area behind it so extensive as most European shells, though Europeans similar to the American in these characters are readily found.

It differs from *P. blandii* by the much shorter and smaller teeth, the palatal fold small and tubercular when present. Some of the thinnest *muscorum* resemble *P. hebes* rather closely.

In limestone districts the white crest and the lip-callus are strongly developed, as in pl. 18, figs. 13, 14 (limestone quarry at Thomaston, Me.), and over much of New York State. Where the rock is granitic or deficient in lime the crest is usually lower, of a reddish brown color but lighter than the

rest of the shell, and the lip-callus is much thinner, pl. 18, figs. 15, 16 (Mt. Desert, Maine). In either form the parietal tooth may occur, but the palatal tubercle is developed only in moderately thick-lipped shells.

Length 3.4 mm., diam. 1.6 mm. Thomaston, Maine.
Length 3.15 mm., diam. 1.55 mm. Thomaston, Maine.
Length 4 mm., diam. 1.7 mm. Mt. Desert, Maine.
Length 3.25 mm., diam. 1.65 mm. Mt. Desert, Maine.
Length 3.35 mm., diam. 1.73 mm. Rochester, N. Y.
Length 3.5 mm., diam. 1.65 mm. Duxbury, Mass.
Length 3 mm., diam. 1.7 mm. Duxbury, Mass.

Eastern North America from Anticosti Island south to Atlantic City, New Jersey, westward in Canada and the northern tier of states; south in the Rocky Mountain region through Colorado to Socorro Co., New Mexico, and northern Arizona; north to Anuk, Alaska. Loess of Iowa and Kansas.

Pupa muscorum Binney, Man. Amer. Land Sh., 1885, p. 78.—Pilsbry and Cockerell, Nautilus, v, p. 45 (varieties).—Blaney, Naut., xviii, pp. 45, 46 (Ironbound I., Me.).—*Pupilla muscorum* L., Whiteaves, Ottawa Naturalist, 1905, p. 171 (Anticosti; Cypress Hills, Assiniboia).—Hanna, Nautilus, vol. 23, p. 94 (Lawrence, Douglas Co., Kansas, in river drift).—Pilsbry, Nautilus, vol. 19, p. 130 (Grant, Valencia Co., N. M.); Proc. A. N. S. Phila., 1906, p. 143 (Benson, Ariz., river drift).—J. Henderson, Univ. of Colo. Studies, ix, p. 57 (Tolland, Ckll.; Eldora, Henderson); Nautilus, xxvii, p. 38 (Clear Creek, Johnson Co., Wyo.).—Cockerell, Naut., xxv, p. 59 (Tolland, Colo.).—Norton, Naut., xxi, p. 6 (Manticus Is., Me.; 3 mm. long; three out of four taken opaque white).—Dall, Harriman Alaska Exped., Moll., p. 28 (Laggan, Alberta; Anuk, Alaska).

Pupa badia C. B. Adams, Boston Journ. N. H., iii, 1840, p. 331, pl. 3, f. 18 (Crown Point, N. Y.).—*Pupilla badia* Ad., Morse, Journ. Portland Soc. N. H., i, 1864, p. 37, f. 89-91, pl. 10, f. 92.—*Pupilla muscorum xerobia* Pils., Nautilus, vol. 28, p. 38, pl. 2, figs. 1, 2. Henderson, Univ. of Colo. Bull., xv, p. 250 (Magnolia, Estes Park, Black Lake Creek, and near Golden, Colo.); Univ. of Colo. Studies, ix, 57 (Floyd Hill, Clear Creek Co., Hand; Eldora, Lake Co., Bethel).

P. muscorum has a far greater zonal or climatic range, as well as a wider geographic distribution in the Palæarctic Region than in America. Our form was doubtless derived from the northern herd of Siberia and northern Europe by way of Alaska, probably in interglacial or Pleistocene time, and has not yet become adapted to warm climates such as the circum-Mediterranean zone which it inhabits in the Old World.

Three-tooth mutations occur as in Europe: the typical form, in which there are no teeth (pl. 18, fig. 15, Mt. Desert, Maine).

Mut. *marginata* Drap. (*unidentata* C. Pfr.). A small, short parietal lamella developed (pl. 18, figs. 13, 14). This includes *P. badia* C. B. Ad.

Mut. *masclaryana* Palad. (*bigranata* auct.). A tubercular or short parietal lamella and a small, tubercular lower-palatal fold present (pl. 18, fig. 12).

Mutation having a columellar tooth more or less well developed, pl. 19, fig. 14. White Oaks, New Mexico. This form has been noticed in America only in the mountain states of the West. Boettger has mentioned its occurrence in France.

The typical mutation, without teeth, is the most abundant and widely-spread in America. Specimens of it usually occur in lots containing *marginata* and *masclaryana*, such colonies being evidently hybrid.

A large series from High Pines, Duxbury, Mass., consists of very thin, toothless shells, with the crest low or very low, not paler, the lip scarcely calloused within. They run down to 3 mm. long, with 5⅓ whorls, and resemble the western *P. hebes*. Similar shells occur as far south as Atlantic City, N. J., in copses in the salt marshes.

Most of the Rocky Mountain specimens seen are of the typical toothless form, and none have a palatal tooth. They vary widely in size. Two from Holbrook, Arizona, measure:

Length 3.85, diam. 1.9 mm., 6½ whorls.

Length 2.75, diam. 1.5 mm., 5¾ whorls.

Pupilla muscorum form *xerobia* Pils., pl. 19, fig. 11, described from an arid sandstone butte near Duran, New Mexico, at 6700-6800 ft., is a small, compact form which I took to

be a race. Similar shells occur in numerous Colorado localities, with intermediate sizes connecting with *muscorum,* so that it is apparently to be regarded as an arid station or hunger form rather than a true race; a view adopted from Prof. Junius Henderson, who has studied it in Colorado. The original description follows.

"Shell small, very short, composed of 5⅓ whorls, the last three forming the cylindric portion, those above forming a very short, obtuse cone; last whorl ascending a little, having a stout buff crest behind the thin, well-expanded lip. There is a small, short, parietal lamella but no other teeth. Length 2.5, diam. 1.5 mm."

Types no. 104005 A. N. S. P. from Duran, N. M. Also found in the following localities, all in Colorado: Trinidad, Pilsbry and Ferriss, 1906; Magnolia, Boulder Co., 8000 ft., D. McAndrews; Estes Park, E. H. Ashmun; Black Lake Creek, T. D. A. Cockerell; near Golden, 7000 ft., E. E. Hand.

The length varies from 2.25 to 2.75 mm. in the lot taken at Duran.

3. Pupilla blandi Morse. Pl. 19, figs. 1 to 5.

Shell rimate, ovate-cylindrical, delicately striated, opaque, light brown. Apex obtuse, nucleus with microscopic granulations. Suture well defined. Whorls 6, subconvex, the last ascending at the aperture, rapidly expanding, with an external whitish callus, between which and the peristome there is a deep constriction. Aperture small, nearly circular, with three obtuse teeth of about equal size: one on the parietal margin, one on the columellar margin, and the third far within and at the base of aperture; peristome subreflected, the margins joined by a thin callus. Length .13 inch, breadth .06 inch [= 3.25 x 1.5 mm.] (*Morse*).

Rocky Mountain region, from Montana (and Red Deer, Alberta) to New Mexico; west to Nevada; eastward in the semiarid region (mainly as a fossil, or in river drift) to McLean Co., North Dakota (at Ft. Berthold, type loc.), Brule Co., South Dakota, Phillips Co., Kansas, Comal Co., Texas.

Pupa blandi W. G. Binney, U. S. Explorations in Nebraska, Doc. 25th Congress, 2d Session, II, pt. ii, p. 725, 1859, name only.—*Pupa blandi* Binney, Land and Freshwater Shells of N. A., I, 1869, p. 235, f. 402; Man. Amer. Land Shells, 1885, p. 188, fig. 188.—v. Martens, Sitzungsber. Ges. Nat. Freunde, 1882, p. 140, as syn. of P. muscorum var. bigranata. — Reinhardt, same Sitzungsber., 1883, p. 37.—Cockerell, Nautilus, x, p. 42 (drift of Rio Grande, Mesilla, N. M.); xiv, pp. 14, 15 (Sandia Mts., and Arroyo Pecos, Las Vegas, N. M.).

Pupilla blandi Morse, Ann. Lyc. N. H. of N. Y., viii, 1865, p. 5, fig. 8.—Tryon, Amer. Journ. Conch., iii, p. 303, pl. 15, f. 4.—Dall, Harriman Alaska Exped., Moll., p. 28 (Red Deer, Alberta). — Pilsbry, Nautilus, xix, p. 130 (Grant, Valencia Co., N. M.).—Pilsbry & Ferriss, Nautilus, xxii, p. 104 (Albuquerque).—Hanna, Nautilus, xxiii, 94 (Douglas Co., Kansas, in river drift); Kansas Univ. Sci. Bull., vii, p. 119 (fossil in Phillips Co., Kansas).—Berry, Nautilus, xxix, p. 125 (Winnecook, Meagher Co., Montana).—Henderson, Nautilus, xxv, p. 59 (Tolland, Gilpin Co., Colo.); Univ. of Colo. Studies, vi, 170, 171; ix, 57 (many Colorado localities; "the most abundant and the most generally distributed of the Colorado Pupillidæ").—Walker, Occas. Pap. Mus. Zool. Univ. Mich., no. 15, 1915, pp. 2-4 (New Mexico at Canones Cr., east of Mt. Pedernal, Coyote Creek near Rio Puerco and Arroyo Angua, all in Rio Arribo Co.; mouth El Cobre canyon, 5 m. north of Albuquerque).—Henderson & Daniels, Proc. A. N. S. Phila., 1916, p. 322 (near Tooele, Utah), 336 (near Franklin, Idaho).

Pupa blandi forma nov. *obtusa* Cockerell, Journ. of Conch., vii, 1892, p. 39.—*Pupilla blandi* var. *alba* Ckll., Nautilus, xviii, Jan. 1905, p. 104 (no description or locality).—*Pupilla blandi pithodes* Pilsbry & Ferriss, Proc. A. N. S. Phila., 1917, p. 103; 1918, p. 328. — *Pupa sublubrica* Ancey, Le Naturaliste, I, April, 1881, p. 389. — W. G. Binney, 2d Suppl. Terr. Moll., v, p. 39, pl. 3, f. 11 (as synonym of *P. muscorum*).

P. blandi is a common shell in the Rocky Mountains, and southward in New Mexico west of the Rio Grande to Grant county; also in the adjacent part of Arizona. It occurs also

in the northern counties of Arizona, in Utah, and (as *P. sublubrica*) in Nevada.

Variation.—1. The typical form, about 3.2 to 3.3 mm. long, 1.5 wide, of 6½ to 6⅔ whorls (pl. 19, figs. 4, 5, near Salt Lake City, Utah) is widely spread in Colorado, eastern Utah and New Mexico. The callus within the lip is moderate or sometimes heavy. The crest behind the lip is well developed.

In some localities there are wider shells: length 3.35, diam. 1.75 mm. North Park, Colorado. The rather thick lip-rib is like typical *blandi*, the wide shell like form *pithodes*.

There are also similarly wide shells (length 3.4, diam. 1.7 mm., Sapello canyon, N. M.) without an internally calloused lip, being thus similar to form *pithodes*, though the parietal fold is not so long.

2. The prevalent or almost exclusive form east of the mountains, from North Dakota to Texas, is small and compact, about 2.5 mm. long, 1.5 wide, of 5½ whorls, the lip often quite strongly thickened. Cockerell has described it as "Form obtusa. 2½ mm. long, broader in proportion to its length than the type. Near the Micawber mine, Custer Co., Colorado." It is probably a "hunger form" occupying arid situations. It occurs in many places in Colorado, in New Mexico, in the Rocky Mountains and along the Rio Grande, mostly known from Pleistocene and river-drift examples. Also in Arizona, from San Pedro river drift near Benson, and in the northeastern counties. Some examples of this race are hardly to be distinguished from *P. sonorana;* but the latter appears to inhabit higher, less arid places than the New Mexican *blandi*.

In some cases longer shells, which would fall into typical *blandi*, are in the same lots with form *obtusa*.

Cockerell has noted a mutation *alba*.

3. Form *pithodes* Pils. & Ferr. (pl. 19, figs. 6, 7) is common under and on dead wood in the forested zone, chiefly among aspens, in the Black Range, between Grant and Sierra counties, New Mexico, 7,000-10,000 ft.; also westward in the Mogollon Mts., 9,500 to 10,000 ft., and in Apache and Graham counties, Arizona. It is wider than typical *P. blandi*, with a

weaker crest; the lip is but slightly thickened within. The shell is short, cylindric with rounded ends, walnut-brown, slightly shining. Whorls somewhat convex, the last slowly ascending a little in front, somewhat flattened and tapering to the narrow base, noticeably contracted behind the lip, having a quite low (or sometimes rather strong) crest of the same color as the rest of the shell. Parietal lamella deeply placed, about one-third of a whorl long. Lower palatal fold rather long. Columellar lamella well developed, short. The type and paratypes, from Sta. 39, Black Range, measure:

Length 3.2, diam. 1.8 mm.; type.

Length 3.7, diam. 1.7 mm.; 7½ whorls.

Length 3.25, diam. 1.75 mm.; 6½ whorls.

Length 3.05, diam. 1.7 mm.; 6⅓ whorls.

In the eastern counties of Arizona this form occurs with *P. hebes,* which it resembles very closely except in having teeth.

P. blandi sublubrica (Ancey).

Pupa sublubrica Ancey was considered by W. G. Binney to be a synonym of *P. muscorum,* but Mr. Ancey in a letter to me stated that it is "a slender var. of *Pupa blandi* Morse." Translation of the original description follows.

"*Pupa sublubrica* C. F. Ancey. Length 3¾, width 1½ mm. Shell elongate, cylindric, thin, pellucid, glossy, rimate, corneous; apex obtuse; closely, minutely, slightly striate. Whorls 8, convex, regular, the last slightly subturgid, then a little contracted at the aperture. Aperture truncate-oval, provided with two teeth within, one parietal, the other opposite this, basal; both white, quite deeply placed. Peristome thin, expanded.

"This species differs from the preceding (*P. hebes*) by the more shining shell, the number of whorls, the striæ of growth even less marked, more obsolete than in *P. hebes,* the more lengthened, more cylindric form, the external swelling and contraction preceding the aperture especially less marked, finally by the two teeth of the latter. Both are situated quite deep in the aperture, one on the parietal wall, the other, elongate, in the base, but a little towards the right. Like *P. hebes,* it is separated from *P. muscorum* L. by the lack of a white calcareous deposit within the aperture. State of Nevada, Dr. Newcomb."

P. blandi charlestonensis n. subsp. Pl. 19, figs. 8, 9. A peculiar race, smaller and otherwise differing from the account of *sublubrica*, and similar to *sonorana*, was taken by Ferriss on Charleston mountain, Lincoln Co., in southern Nevada.

There is a well-developed crest behind the lip. The parietal lamella and lower palatal fold are strong and long; columellar nodule distinct. Length 3, diam. 1.4 mm.; 6½ whorls.

This might be considered a form of *P. sonorana* were it not so remote from the known range of that species.

4. Pupilla sonorana (Sterki). Pl. 19, figs. 10, 12, 13, 15.

Shell perforate-rimate, cylindrical, apex obtuse, rounded; color brownish-horn; surface finely striated-rugulose, more coarsely so near the aperture; whorls 6½, gradually increasing; suture rather deep; the last whorl comparatively small, compressed in its inferior part, the base narrow, almost keeled; near the aperture a high, sharp bulging [crest] filled with a strong whitish callus, shining through the shell; a narrow, deep constriction in front of it, and an impression over the palatal fold. Aperture rather small; margins abruptly but rather narrowly everted; lamellæ and folds 3, white; parietal rather deep-seated, long, spiral; columellar perpendicular (along the columella), lamellar; palatal (the inferior) rather strong, often with a thread-like prolongation inward. Alt. 2.6, diam. 1.3 mm. (*Sterki*).

Length 3.25, diam. above apert. 1.4 mm.; 7¼ whorls. Topotype.

Length 2.75, diam. above apert. 1.3 mm.; 6½ whorls. Topotype.

Length 3.05, diam. above apert. 1.4 mm.; 7 whorls. Cloudcroft.

Length 2.5, diam. above apert. 1.3 mm.; 6 whorls. Cloudcroft.

New Mexico: Whiteoaks (type loc.), Gilmores, Mescale (E. H. Ashmun); James canyon, Cloudcroft, Sacramento Mts. (Rehn and Viereck); summit of Hacheta Grande, 8,500 ft.,

Big Hachet Mts. (Pilsbry and Daniels); 14 miles northeast of Tucumcari, Cuervo River, San Miguel Co., and Turkey Creek, near Wagon Mound, Mora Co. (Dr. E. C. Case).

Pupa (Pupilla) sonorana Sterki, Nautilus, xii, March, 1899, p. 128, with var. *tenella*, p. 129.—*Pupilla sonorana* Sterki, Pilsbry, Proc. A. N. S. Phila., 1915, p. 345.—Walker, Occas. Pap. Mus. Zool. Univ. Michigan, no. 15, 1915, pp. 4, 5.

P. sonorana differs from *P. blandi* by its much longer parietal lamella (fig. 10) and the far greater impression of the last whorl preceding the crest (fig. 13). The columellar lamella is longer. *P. syngenes dextroversa* is a longer species with more whorls and less impressed base.

In most lots seen there are longer, shorter and intermediate individuals.

In one lot from Clouderoft, in the Sacramento mountains, there are two examples with an upper-palatal tubercle also, making four teeth in all (pl. 19, fig. 12).

This species would hardly be considered specifically distinct from *P. triplicata* of Europe were it not that the two inhabit antipodal parts of the globe.

P. sonorana form *tenella* (Sterki). Shell rather oblong or ovoid; the bulging in the palate less high, and only with a slight callus inside. Most specimens are less high than the types, 2.3 to 2.6 mm. (*Sterki*).

New Mexico: Capitan Mts. (Ashmun).

The specimens before me, part of the original lot, differ very little from typical *P. sonorana;* the crest is often fully as high as in that. It seems scarcely separable as a race. One measures, length 2.7, diam. above aperture 1.45 mm.

5. Pupilla hebes (Ancey). Pl. 18, figs. 1 to 4.

"Shell subcylindric, rather thin, rimate, obtuse at the apex, corneous-tawny, very minutely scarcely striatulate. Whorls 6-7, strongly convex, joined by a deep suture, regularly increasing, the last swollen towards the aperture, then deeply contracted. Aperture truncate-suboval, toothless, or provided with a small parietal tubercle, not thickened within. Peristome thin, reflected. Length 3.25, width 1.5 mm. (*Ancey*).

"*P. hebes* has so much affinity [to *P. muscorum*] that I would have hesitated to separate them if it were not that all my specimens have the same peculiarity, the absence of a white calcareous deposit within the aperture; a character as everyone knows, of *P. muscorum*."

Idaho: Banks of Salmon River (Hemphill); near mouth of St. Charles canyon, west of St. Charles (Henderson and Daniels).

Nevada: White Pine, type loc.; near Austin, Lander Co. (Hemphill).

Utah: Blue Mts. and on Monticello Creek, San Juan Co. (Ferriss).

Arizona: mountains and high country throughout the state from Coconino and Yavapai counties east, south to the Huachuca and Chiricahua Mts., Cochise Co. (Ashmun, Ferriss and Pilsbry); usually between 5000 and 9500 ft., in humid localities or stations, often abundant.

Pupa hebes C. F. D'ANCEY, Le Naturaliste, iii, April, 1881, p. 389.—PILSBRY & VANATTA, Proc. A. N. S. Phila., 1900, p. 589, pl. 22, f. 9, 10. Not *P. hebes* PILSBRY, Nautilus, xi, p. 117.—*Pupilla hebes* (Anc.), PILSBRY & FERRISS, Proc. A. N. S. Phila., 1911, p. 197, with *Pupilla hebes kaibabensis*, n. subsp. —FERRISS, Nautilus, vol. 34, p. 14, with mut. *albescens*.

Pupa arizonensis Gabb, W. G. BINNEY, 2d Suppl. Terr. Moll., v, p. 40, pl. 3, f. 12, specimen from Ancey. Not of Gabb.

Pupilla muscorum idahoensis HENDERSON and DANIELS, Proc. A. N. S. Phila., 1917, p. 57.

The absence of a white or tawny callus within the lip distinguishes *P. hebes* from typical *P. muscorum*. It never has teeth, such as *P. blandi* and many *muscorum* possess. There is a decided contraction behind the outer lip; typically there is scarcely any crest, and no yellowish streak, but sometimes the crest is well developed.

Length 4, diam. 1.85 mm., 7 whorls. Bill Williams Mt.

Length 3.1, diam. 1.65 mm., 5¾ whorls. Bill Williams Mt.

Length 3.5, diam. 1.6 mm., 7 whorls. Lander Co., Nev.

Length 3.25, diam. 1.55 to 1.6 mm. Lander Co., Nev.

Length 2.7, diam. 1.65 mm., 6½ whorls. Rucker Co., Chiricahuas.

While *P. hebes* occurs near the eastern boundary of Arizona in Apache and Graham counties, it has not been found in New Mexico. The Utah localities are in the southeastern angle of the state. It has been reported from Tecumseh and Lawrence counties, Kansas, in river drift (Hanna, Nautilus, vol. 23, p. 94), but I have not seen these specimens, and their identity should be confirmed.

An albino form, mut. *albescens* Ferriss, was taken among aspens at the Betatakin ruins in northern Arizona, small numbers being associated with many specimens of the usual chestnut-brown color. Similar albinos were taken in one place on Mt. Lemon, in the Santa Catalina range, also with brown specimens, 6 albinos to 122 brown shells.

Form *kaibabensis* P. & F., from the Kaibab Saddle, north of the Grand Canyon, Arizona, was distinguished from *hebes* by its shorter form, length 2.7 to 2.8 mm., diam. 1.5 mm., 5½ whorls. While all of the specimens from the northern environs of the Canyon were of this form, similar short ones also occur in other lots from south of the canyon in northern Arizona, sometimes associated with larger ones; also in Rucker Canyon, in the Chiricahua Mts., where all are small. I now regard *kaibabensis* as a stunted or hunger form, the diminished stature being probably traceable to locally unfavorable conditions which affect all individuals of a colony. It is probably not of racial significance.

Pupilla muscorum idahoensis H. & D. (pl. 19, figs. 18, 19) resembles closely the *hebes* of Nevada, and does not seem to be racially distinct. It is not, in my opinion, a form of *muscorum*. The crest is often strongly developed, as in *muscorum*, but very weak in other specimens. The lip is thin, as usual. It is from St. Charles, southern Idaho. Two measure:

Length 3.3, diam. 1.47 mm.; 6¼ whorls.

Length 3.1, diam. 1.5 mm.; 6 whorls.

P. hebes nefas Pilsbry & Ferriss. Pl. 18, figs. 5 to 8.

The shell is sinistral, usually with a small parietal lamella;

in oblique view in the aperture a columellar tubercle may be seen. It differs from *P. syngenes* by the absence of a crest behind the lip, though there is a wide, shallow contraction there.

Length 4.2, diam. 1.75 mm., 7⅓ whorls. Spud Rock.

Length 3.65, diam. 1.9 mm., 7 whorls. S. Catalina Mts.

Length 3.2, diam. 1.85 mm., 6½ whorls. S. Catalina Mts.

Arizona: Santa Catalina Mountains, Pima Co., abundant, generally distributed from 8000 to 9500 ft.; Spud Rock, Rincon Mts.; Chiricahua Mts., Cochise Co., at the head of Cove Creek, 8000 ft., and Pine Canyon, 7500 ft., type loc. (Ferriss).

Pupilla hebes form *nefas* Pils. & Ferr., Proc. A. N. S. Phila., 1910, p. 135.—*P. h. nefas* Pils. & Ferr., op. cit., 1918, p. 303.

In the Chiricahuas this race was not found associated with the dextral *hebes*, which was taken in Rucker canyon. In the Santa Catalina and Rincon mountains it was found at 11 stations, often in large numbers, but in only one place, near Marshall Pass, were *hebes* and *nefas* found together.

This sinistral race evidently appeared as a mutation somewhere in southeastern Arizona, and as yet has spread over only a few ranges of that region. Nothing has been seen of it in the extensive regions north and northwest, inhabited by dextral *hebes*.

6. Pupilla syngenes (Pilsbry). Pl. 18, figs. 9, 10, 11.

The shell is sinistral, cylindrical but somewhat wider above, blunt at each end; cinnamon brown, or somewhat darker. Surface dull when fresh, delicately obliquely striate. Apex large, obtuse; suture impressed; whorls 8, the last one compressed and flattened around the lower-outer portion, its last third ascending on the next earlier whorl, and elevated into a high rounded ridge or crest a short distance behind the outer lip. Aperture slightly oblique, truncate-oval in form; the outer lip narrowly expanded, basal and columellar margins broader; about the middle of the parietal wall, or nearer the upper end, there is a small parietal lamella about one-fourth of a whorl long. Far within there may be seen a blunt columellar lamella; and most specimens exhibit far within the outer lip a tubercular lower-palatal fold.

Length 3.3, diam. 1.75 mm.; 8 whorls. Type, fig. 9.
Length 4.15, diam. 1.7 mm.; 9 whorls. Yavapai Co.
Length 3, diam. 1.75 mm.; 7 whorls. Grand Canyon.

Pupa syngenes Pils., Nautilus, iv, p. 3, May, 1890, pp. 3, 39, pl. 1, f. 7; v, p. 39, pl. 2, f. 1, 2; Proc. A. N. S. Phila., 1890, p. 296. — Dall, Nautilus, viii, p. 35. — Pilsbry & Vanatta, Proc. A. N. S. Phila., 1900, p. 606, with form *dextroversa*.—Dall, Nautilus, vii, p. 35.—*Pupilla syngenes* Pilsbry, Proc. A. N. S. Phila., 1911, pp. 193-195, f. 7, with *P. s. dextroversa*, pp. 193-195, f. 6, 8, and *P. s. avus*, p. 196, f. 9.—*Pupilla syngenes dextroversa* P. & V., Cockerell, Nautilus, xxv, p. 59.—Henderson, Univ. of Colo. Studies, x, p. 57.

New Mexico: San Rafael, Valencia Co. (Ashmun). Arizona: Holbrook (Ashmun), Black Mesa (Ferriss), Navajo Co.; branch of Chinle Creek, Apache Co. (Ferriss); Jerome and Purtyman's ranch, Oak Creek, Yavapai Co. (Ashmun); upper levels of the Grand Canyon at Bright Angel trail and

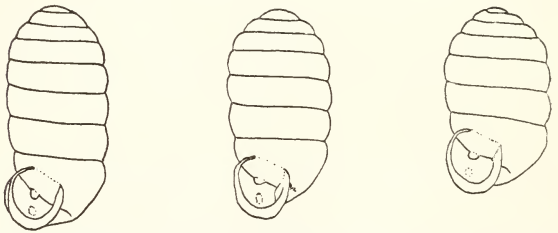

Fig. 1.—*Pupilla syngenes* Pils. Spectacle Cove near Bass Trail, Grand Canyon. Lengths 3.8, 3.5 and 3.2 mm.

Bass trail (Pilsbry & Ferriss), and north of the river at numerous places on Powell and Kaibab Plateaus (Ferriss & Daniels). Montana: Beaver Creek, a trib. of Little Missouri R., in drift débris (Dall).

This species differs from *P. muscorum* by the longer parietal lamella, the more numerous whorls, the last having a stronger crest and ascending further, the lip less expanded, and the shape, wider above. It is more nearly related to the

smaller *P. sonorana,* which occupies an area to the east and south of *syngenes,* the northern colonies of *sonorana* being separated from the nearest *syngenes* by the Rio Grande valley.

The type specimen has no palatal tubercle, but in most colonies the lower-palatal is usually developed. There is great variation in length. A lot from Spectacle Cove, Bass trail, in the Grand Canyon, contains shells from 3 mm. long, of 7 whorls, to those 3.7 mm. of 8 whorls. Some of those from the Kaibab Plateau are very long, over 4 mm., of fully 9 whorls.

Mut. *nivea.* At Marsh Pass, Black Mesa, Navajo Co., Arizona, Ferriss found beautiful albino specimens (pl. 18, fig. 11) together with the brown ones. This mutation also occurs in some Grand Canyon lots.

"*Pupilla syngenes* Pils. and *P. syngenes dextroversa* seek the well-drained hillsides where grass roots and spawls of stone lying upon the soil furnish shelter. So far they have not been gathered in deep forest conditions where pupas mostly congregate" (*Ferriss*). Both are arid country forms of the plateau of northern Arizona, apparently distributed generally, but not found far north of the Colorado river. The records from Montana and northern Colorado, far from the main herd, appear to indicate extension north in western Colorado or eastern Utah, regions as yet but little explored for shells.

The record of a half specimen from Benson, Arizona (Proc. A. N. S. Phila., 1915, p. 390), I now think was based on a sinistral specimen of some other species. The shape of the summit is not quite right for *syngenes,* and the later whorls are wanting. That locality lies several hundred miles from the nearest known locality for *P. syngenes.*

P. syngenes dextroversa (P. & V.). Figs. 2, 3.

Similar to the typical form, but dextral. The shell is subcylindric, a little wider near the upper end. The last whorl is flattened laterally, with a strong, rounded crest followed by a deep constriction behind the lip, which is thin and very

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narrowly expanded. The parietal lamella is slightly over one-fourth of a whorl long; the columellar lamella small and deeply immersed, and the lower palatal nodule well developed or weak, but invariably present in adult shells.

Length 4, diam. 1.7 mm.; 9 whorls. San Rafael.
Length 3, diam. 1.6 mm.; 7½ whorls. San Rafael.
Length 4.5, diam. 1.8 mm.; 10 whorls. Grand Canyon.
Length 3.7, diam. 1.8 mm.; 9 whorls. Grand Canyon.

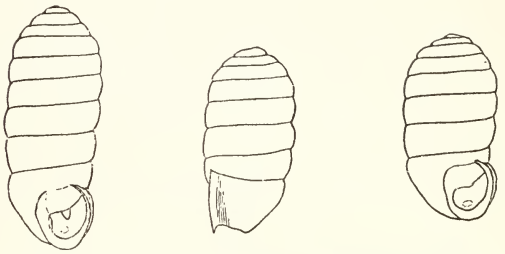


Fig. 2.—*P. s. dextroversa* P. & V. San Rafael, N. M.

New Mexico: San Rafael* (type loc., Ashmun), and Grant (Baily), Valencia Co. Arizona: Holbrook* (Ashmun); Grand Canyon, Bright Angel Trail,* and just below the south rim near Bass Camp (Ferriss & Pilsbry), and in Stone House Gulch, Kaibab Plateau* (Ferriss & Daniels). Colorado: Tolland, Gilpin Co. (Cockerell) and Eldora, Boulder Co. (Henderson).

At localities marked with a * it occurred in association with sinistral *P. syngenes.*

This form differs from *P. muscorum* by the shape and number of whorls of the shell, and the longer parietal lamella.

P. s. dextroversa differs from *P. syngenes* only by the dextral coil. Since dextral forms are doubtless the more primitive in *Pupilla*, it is evidently *dextroversa* which perpetuates the original stock of the species. Perhaps it might be ranked as a mutation rather than a subspecies. In half of the localities given above, only dextral shells were found; but at the

two in Colorado only single shells were taken. In a few colonies, so far as our information goes, the dextral form

FIG. 3.—*P. s. dextroversa* P. & V. Bass Trail, Grand Canyon, about 200 ft. below the rim. Lengths 4.5 and 3.75 mm.

occurs as a pure race, and many more colonies are of purely sinistral shells.

The Colorado records quoted from Cockerell and Henderson are widely detached from those in New Mexico and Arizona. All of the material from the latter states has been examined by the writer.

P. syngenes avus Pils. & Ferr. Fig. 4.

Shell sinistral, the last whorl deviating tangentially and ascending; teeth deeply immersed; *parietal lamella much longer* than in *P. syngenes* or *dextroversa*, about a half-whorl long.

Length 5.2, diam. 1.8 mm., whorls 10½.

Length 4.3, diam. 1.7 mm., whorls 9½.

Length 4.0, diam. 1.7 mm., whorls 9½.

Types no. 94,220 A. N. S. P., from upper slope of the Grand Canyon along the Mystic Spring or Bass Trail, about 200 feet below the rim; abundant with *P. s. dextroversa*.

The special characters of this race, being those of senility, are unequally developed in different individuals. The figures give a fair idea of the variations. Finding these shells asso-

ciated with about an equal number of *P. s. dextroversa* of about the same size, we at first were disposed to think them all one race in which the shell was indifferently dextral or sinistral; but on closer study it appears that the dextral

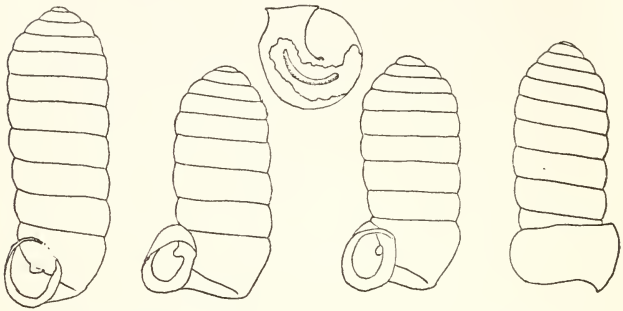


FIG. 4.—*Pupilla syngenes avus,* Cotypes. Lengths 5.2, 4, 4 and 4.2 mm.

forms never have the last whorl and aperture abnormal nor are the teeth so deeply immersed, or the parietal lamella so long, while almost every sinistral shell collected in this colony is markedly distorted. It seems, therefore, that although the two forms are of common origin and live together, the different direction of the coil probably prevents interbreeding, thus segregating the sinistral stock, which in this colony is now in a late stage of senile degeneration.

II. SPECIES OF EUROPE AND NORTHERN AFRICA.

Like the American group, these present all stages in the degeneration of the teeth. Recent European forms have 0 to 3 teeth, like the American, belonging to the section *Pupilla.* In Asia the more primitive group *Primipupilla,* species with 4 or 5 teeth, lingers on, associated with the modernized forms.

The variations in teeth, in shape and development of the prelabial crest, have led to the naming of many "varieties", part of them true geographic races, many others being muta-

tions complexly interrelated and of little significance from the standpoint of systematics alone. The varietal subdivisions of European Pupillidæ are a creation of ignorance, stupidity, industry and insight, which an outsider can record but cannot systematize.

P. poltavica, no. 21, a Russian Pleistocene species, is placed among the Asiatic forms in order to get it among its relatives in the section *Primipupilla*.

Two undescribed species of *Pupa* have been referred to *Pupilla*.

P. kuschakewitzi v. Martens. Tkeso Narynkol, an undescribed Russian species, has been mentioned by Boettger as related to the Miocene *P. rahti*. Jahrb. Nassau. Ver. Nat., 42, 1889, p. 254.

[*Pupa* (*Pupilla*)] *poupillieri* Bourg. Algier. Paetel, Catalog der Conch.-Sammlung von Fr. Paetel, 1873, p. 108.

P. genesii Gredl. (vol. xxv, p. 204) is referred to *Pupilla* by Kobelt on account of the presence of inferior tentacles (Iconographie, 2 ser., viii, p. 82).

Series of *P. muscorum* (*Pupilla* proper).

The aperture has 0 to 3 (rarely 4) teeth, no angular lamella. Embryonic whorls minutely, weakly granose, or with a net-work of slightly impressed lines separating flat, irregularly rounded grains, mosaic-like.

7. Pupilla muscorum (L.). Pl. 20, figs. 1 to 7.

The shell is shortly rimate, cylindric, auburn or some similar brown shade, white or light behind the lip, moderately solid. Summit rounded, obtuse. First 1¾ whorls nearly smooth, the rest with fine, blunt, uneven striation, moderately convex; last half of the last whorl tapering downward, compressed, rising to the aperture, having a strong whitish crest near and parallel to the outer and basal lip. The aperture is somewhat oblique, truncate-rounded, typically without teeth (but in various varieties or mutations provided with one to three teeth). Peristome narrowly reflected outwardly, broadly on the columellar side, having a strong pale callus within.

Fig. 2. Length 4.6, diam. 1.95 mm., 7 whorls. Hunstanton, England.

Fig. 1. Length 4, diam. 1.8 mm., 6¾ whorls. Hunstanton.

Fig. 3. Length 3.15, diam. 1.75 mm., 6 whorls. Pensarm, N. Wales.

Fig. 4. Length 2.7, diam. 1.7 mm., 5¼ whorls. Pensarm, N. Wales.

Fig. 7. Length 3.5, diam. 1.65 mm., 7 whorls. Calvados.

Fig. 6. Length 2.6, diam. 1.6 mm., 6 whorls. Calvados.

Palæarctic Region, generally distributed over Europe, north Africa, northern and central Asia, south to Persia; part of North America.

Turbo muscorum L., Syst. Nat., x, p. 767.—Hanley, Ipsa Linn. Conch., p. 352, pl. 4, f. 6, Linne's type specimen.—*Pupa muscorum* L., Rossmaessler, Iconographie, i, p. 83, f. 37; v, f. 323.—Kuester, Syst. Conch. Cab., *Pupa*, p. 12, pl. 2, f. 1-5. —Pfr., Monogr., ii, p. 311; iii, 536; iv, 665; vi, 304.—Westerlund, Fauna, 1887, p. 121.—Moquin-Tandon, Moll. France, ii, 1855, p. 392, pl. 28, f. 5-15, with var. *edentula*. — Wiegmann, Jahrb. D. M. Ges., iii, p. 212 (radula of immature stages).—Kennard and Woodward, Proc. Malac. Soc. Lond., iii, p. 194 (Pliocene of England and Amsterdam).—Godwin-Austen, P. Mal. Soc., iii, 260 (Pangkong Lake and Ladak, Kashmir, and Yarkand. — Hilber, S. B. Math.-Nat. Cl. K. Akad. Wissensch., Wien, 88 Bd., 1 Abth., 1884, p. 1376, pl. 6, f. 9 (localities in Prov. Kan-su, China, etc.).—*Pupilla muscorum* L., Beck, Index Molluscorum, 1837, p. 84 (with var. a, *normalis*, = typical form).—Boettger, Jahrb. Nassau. Ver. Naturkunde, 42, 1889, p. 263. — Gude, Fauna Brit. India, Moll., ii, p. 282.—Schlesch, Land- og vatna-lindyr a Islandi, 1921, p. 16 (Iceland).—*Pupa (Pupilla) muscorum* var. *edentula* Slavik, Archiv naturwiss. Landesdurchforschung von Böhmen, i, sect. iv, 1868, p. 110 (Bohemia, with the 1-toothed and the 2-toothed *muscorum*). — A. Weber, Abh. K. Bayer. Ak. Wiss., xxvi, 5 Abh., 1913, p. 17 (localities in Thian-Shan). —*Jaminia muscorum* m. *sinistrorsum* and var. *alba* J. W. Baldwin, Journ. of Conch., xi, 1904, p. 11 (Abersoch, North Wales).—Kennard & Woodward, Journ. Linn. Soc. Lond. 34, Zool., 1920, p. 209 (Linnean type).

Pupa unidentata C. Pfeiffer, Syst. Anord. u. Beschreib. deutscher Land- und Süsswasser-Schnecken, 1821, p. 58, pl. 3, f. 19, 20.

Pupa bidentata C. Pfeiffer, Syst. Anord. u. Beschreib. deutscher Land- und Süsswasser-Schn., 1821, p. 59, pl. 3, f. 21, 22 (Schlosse zu Felsburg).

Pupa marginata Draparnaud, Tableau Moll. Fr., 1801, p. 58; Histoire, p. 61, pl. 3, f. 36-38.—Jeffreys, Brit. Conch., ii, 1862, p. 249, and of many European authors.

Pupilla simplex Locard, Ann. d'Agricult. Lyon, (7), iii, 1896, p. 217; Conchyl. Fr., 1894, p. 329 (toothless form of *muscorum*).

Pupa masclaryana Paladilhe, Nouv. Misc. Malac., i, 1866, p. 11, pl. 1, f. 1-3.

P. muscorum is characterized by the strong whitish crest, the thickening within the lip, weak striation, and absence or, when present, the small size of the parietal and lower palatal teeth. There is usually no columellar tooth or nodule, but in the Rocky Mountains a small columellar tooth is frequent, and Boettger has noted its presence in a Marseilles specimen.

Varieties according to the teeth.—Shells having the typical shape of *muscorum* (which varies, however, from short to long in the same colonies) are classed by the number of teeth, in three (or four) varieties, spread over the whole European range of the species.

1. Without teeth (pl. 20, fig. 1). This is the typical form of *muscorum;* the name var. *edentula* Moq. used by many authors and *simplex* of Locard are superfluous. It sometimes occurs in pure colonies, more frequently associated with the following.

2. Having a short parietal but no other teeth (pl. 20, fig. 3). The earliest name for this form is mut. *marginata* Drap. It is generally called var. *unidentata* C. Pfr. The commonest European form by far, often occurring with the preceding and less commonly with the following forms. ,

3. Having short parietal and lower-palatal teeth (pl. 20, fig. 7). This is mut. *masclaryana* Palad., which was based upon an unusually short shell, pl. 20, figs. 16, 17. It has

generally been called var. *bigranata* Rossm., but that appears to be a special Central European form considered a separate species by some authors. I do not know that *masclaryana* ever occurs in pure colonies; it is associated with the preceding.

4. Var. *tridentata* Jeffreys has three teeth, one on the columella being added. Recent naturalists do not appear to have noticed it, and it is not to be found in the Jeffreys collection. However, it seems to be what has been called var. *glis* Westerlund.

This is a case where three forms have been initiated by the loss of teeth by successive mutations; probably these mutations have time and again occurred independently. They cannot properly be ranked as subspecies, but rather as mutations. Other mutations have the shell white or reversed, long or short; these are independent of tooth mutations.

Other named tooth-mutations follow below, the original accounts being given in all cases.

Draparnaud in the *Tableau*, 1801, defined *Pupa marginata* thus: "Coq. ouverture 1-plissée; péristome garni extérieurement d'un bourrelet blanc. Long. 3 mill., diam. 2 m. 6 tours." In the *Histoire*, 1806, he enlarged the definition to include specimens with a lower-palatal fold; yet this later description apparently included some shells we would not now include in *muscorum*, such as those having "une dent ou lame qui se prolonge en tournant dans l'interieur de la coquille." It is evident that *marginata* can be properly used only for the form usually termed unidentata. This is what Draparnaud first described, and later figured.

Mut. *bidentata* C. Pfr. was evidently an abnormal shell, having two blunt denticles standing close together on the parietal wall.

Mut. *tridentata* Jeffr. A remarkable variety, the arrangement of the teeth being the same as in P. tridentata [? *triplicata*]. Between Bex and St. Maurice, Switzerland (*Pupa muscorum* var. *tridentata* Jeffreys, Ann. Mag. N. H. (2), xv, 1855, p. 22).

Mut. *masclaryana* Paladilhe. Pl. 20, figs. 16, 17. Shell

minute, rimate-perforate, obese-ventricose, rather solid, quite opaque, corneous, under the lens very sharply striatulate; spire obese, obtusely tapering, at the apex paler. Whorls 6½, a little convex, regularly and slowly increasing, separated by a strongly impressed suture, the last whorl one-third the altitude, regularly ascending, at the base a little compressed, at the aperture constricted-subplanulate behind the external lip of the peristome. Aperture small, a little oblique, lunate-coarctate, biplicate; one parietal fold, very minute and deeply placed, the other fold palatal, stronger, white and immersed; peristome lightly thickened within, subacute, somewhat expanded at the base and columella, externally having a whitish, roughened lip; margins joined by a thin callus. Alt. 3, diam. 2 mm. Under stones at the entrance of the Valette near Montpellier (Paladilhe).

Mut. *glis* Westerlund). Pl. 20, fig. 20. Perforate-rimate, ovate-cylindric, densely striatulate, rufescent; whorls 6½, a little convex, separated by a little impressed, margined suture, slowly increasing, the last ascending, at the aperture descending, anteriorly with a widely diffused white callus, separated from the lip by a groove. Aperture semicircular, margins distant, strongly lipped within, having a high, long parietal lamella, and within the palate behind the outer margin two strong, granule-like teeth. Length 3, diam. 1⅞ mm.

England: Yorkshire (J. Ponsonby); Brandon, Suffolk (Chester, Mayfield).

Pupa (Pupilla) muscorum Lin. var. *glis* Westerlund, Nachrbl. D. Malak. Ges., Aug. 1893, p. 120.—*Jaminia triplicata* Studer Chaster, Journ. of Conch., xi, p. 319 (Brandon, Suffolk, England); *cf.* Dean and Tomlin, Journ. of Conch., xv, 1917, p. 165, fig. 2.

Dean and Tomlin have shown that the English form is a form of *muscorum*, lighter in color than typical, with more solid shell; "some are bidentate, while others have in addition a deep-seated callosity on the columella, difficult to see from any point of view." It seems to be what Jeffreys called var. *tridentata*.

Various color and shape mutations follow; perhaps some of them are geographic races.

Mut. *albina* (Menke, Syn. meth. Moll., 1828, p. 18, name only), Moquin-Tandon, Moll. Fr., ii, 392. Shell entirely whitish. France. Also in England, Somersetshire, Oxfordshire, Worcestershire; as var. *alba* Baldwin in North Wales.

Mut. *sinistrorsa* Baldwin. A sinistral individual. North Wales.

Mut. *brevis* Bandon. Very short. Dép. Oise (*Pupa muscorum* var. *brevis* Bandon, Nouv. Catal. Moll. Dép. de l'Oise, 1862, p. 27). Also reported from England (J. of Conch., iv, 376; 2 x 1.5 mm., toothless) and under various names from many countries. The name is preoccupied.

Mut. *abbreviata* 'Ulicny' Clessin. Pl. 20, fig. 8. Shortened; whorls more slowly increasing and narrower. Length 2.5, diam. 1.4 mm. Mähren, Polauer mountains near Brünn (*Pupilla muscorum* var. *abbreviata* Ulicny in schedis, Clessin, Molluskenfauna Oesterreich-Ungarno u. der Schweiz, 1887, p. 257, f. 157.

Mut. *minor* West. Compact, with 6 convex whorls; margins of the peristome approaching one another. 3 x 1.75 mm., no loc. (*Pupa muscorum forma minor* Westerlund, Fauna, 1887, p. 121).

Mut. *pratensis* Clessin. Pl. 20, fig. 9. Larger and broader, thinner shelled, darker brown with parietal tooth weak or lacking. 3.5 x 1.9 mm. Southern Bavaria. (Clessin, Fauna von Augsburg, 1871, p. 101; Molluskenfauna Oesterreich-Ungarns u. Schweiz, 1887, p. 256, f. 155). "Apparently spread over the entire region, but so far certainly taken only in Moravia (Mähren). Found only on very moist meadows with peat subsoil." Figure from Clessin.

Mut. *elongata* Clessin. Pl. 20, fig. 10. Shell longer, of more cylindric form, consisting of 8 whorls. Length 3-8, diam. 1.7 mm. On cold, calcareous meadows, Germany (*Pupa muscorum* var. *elongata* Clessin, Deutsche Exeursions-Mollusken-Fauna, 1876, p. 202.

In the Mollusken-fauna Oesterreich-Ungarns, 1887, p. 256, Clessin gives the length as 4, diam. 1.5 mm. He says that it is distributed apparently over the entire region, but scattered individually among normal examples.

Mut. *milaschevitschi* Lindholm. Shell elongate-cylindric, dark rufous-brown, the cervical callus paler; whorls 7-8, the last distinctly ascending in front; aperture always having a nodiform tooth in the palate below the middle (and very rarely an obsolete, punctiform tooth on the parietal wall). Alt. 3.5 to 4, width 1.6 to 1.7 mm.

Russia: Gouvernement Ssimbirsk, in low, moist parts of a shady garden in Staro-Timoschkino. Also in two places in the Moskow Gouvernement.

Stands very near var. *elongata* Cless. but differs by the constant palatal tooth (*Pupilla muscorum* var. *milaschevitschi* Lindholm, Nachrbl. D. Mal. Ges., 43, March, 1911, p. 39).

P. MUSCORUM ASIATICA Mlldff. Always toothless; form more elongate; palatal callus weaker.

High Asia: Ladak, many places in Turkestan; western Himalaya. Kukunor region, Prov. Gan-su, China; Bo-hua-shan, near Peking (*Pupilla muscorum* L. subsp. *asiatica* Moellendorff, Annuaire Mus. Zool. Acad. Imp. Sci. St. Petersb., vi, 1901, p. 381).

According to Andreae, *P. m.* var. *elongata* Cless. is widely spread in central Asia and western China, largely in the loess (Futterer's Durch Asien, iii, 1911, p. 70). What he had is evidently Moellendorff's subsp. *asiatica*, which does not appear to differ in characters from the European mutation *elongata*. In Central Asia, however, the long form may have racial constancy.

P. MUSCORUM LUNDSTRÖMI (West.).

Shell ovate-cylindric, glossy, brown. Whorls *convex*, the last somewhat higher but shorter than the penult, above *strongly and extended ascending with a narrow transverse callus* [crest] *colored like the rest of the shell*, at the aperture, *compressed below*. Aperture ovate-rounded; peristome very narrowly reflected; outer margin strongly arcuate above, in-

serted *above the middle* of the penult whorl. Columellar margin somewhat extended. Length 3⅔, diam. 1¾ mm. or smaller (*Westerlund*).

Siberia: Jenissei, 69° 15′ N. Lat.; Pupkowskij, 64° 42′. Norway: Lofoten Is. Sweden, Iceland, Turkestan, along the Kisilart river, in the alpine meadows.

Pupa muscorum var. *lundströmi* WESTERLUND, Nachr. D. Malak. Ges., viii, 1876, p. 98; Siberiens Moll., in Kongl. Sv. Vet. Akad. Handl., xiv, no. 12, 1876, p. 41; Ann. Mus. Zool. Acad. Imp. Sci. St. Petersb., iii, 1898, p. 181. — *Pupa lundströmi* WEST., Fauna, iii, 1887, p. 122.

The extended and strongly ascending last whorl, and absence of a white callus behind the lip differentiate this from *muscorum*, of which it is doubtless a subspecies. Von Martens has erroneously placed it as a synonym of *P. signata*.

P. MUSCORUM INOPS (Reinh.). Pl. 20, figs. 12, 13. The palatal folds are entirely lacking, and the teeth of the parietal wall and columella are much more weakly developed [than in *P. triplicata*], becoming thereby similar to *P. muscorum*, from which it is separated by the smaller size, the delicate structure of the shell as well as by the tooth on the columella (*Reinh.*).

Transcaucasus: Borschom, type loc.; Mamudly; on the Kasbek.

[*Pupa triplicata*] var. *inops* REINHARDT, Jahrb. D. Malak. Ges., iv, 1877, p. 79, pl. 3, f. 3. — *Pupa muscorum* var. *caucasica* BOETTGER, Jahrb., vi, 1879, p. 399; vii, p. 136.—*P. triplicata* var. *cylindrata* BOETTGER, Jahrb., vii, 1879, p. 26.

Var. *cylindrata* was thus defined: It is somewhat larger than the middle European form of *P. triplicata*, has a length of 3 mm., breadth 1½ mm., with 6-7 whorls, and is distinguished by the entire lack of all teeth, even usually the columellar tooth. Mamudly. Boettger subsequently recognized its identity with *inops* and *caucasica*.

Westerlund agrees with Reinhardt in placing this form as a variety under *triplicata*, while Boettger subordinates it to *muscorum*. I have not seen it.

Descriptions of forms considered synonyms of *muscorum* follow.

Pupilla saliniensis 'Bgt.' Locard. Subcylindric, a little elongate; 7 quite convex whorls, suture quite deep; umbilicus moderate; aperture relatively small, quite round; peristome interrupted, a little thick, quite reflected, with a strong, white, external crest; one dentiform superior fold, exactly median, a little immersed; shell a little thin, corneous light red, a little transparent, ornamented with fine striæ. Alt. 3½, diam. 1¼ mm. Rare. Salins (Jura). (*Locard*, Ann. d'Agricult. Lyon, (7), iii, 1896, p. 217; Conchyl. Fr., 1894, 329.)

Var. *transsilvanica* Kimakowicz. The Transylvanian form is distinguished from that of Western Europe by the quite flat whorls, separated by very shallow suture, and further by the almost invariable lack of the denticle on the parietal wall (the palatal denticle is never present), and by the relatively weakly developed peristomial callus. The size varies from, alt. 2.5, diam. 1.5 mm., 6 whorls, to 3.7 : 1.7, 7 whorls (*Pupilla muscorum* var. *transsilvanica* Kim., Verh. u. Mittheil. Siebenbürg. Ver. naturwiss. in Hermannstadt, xl, 1890, p. 106).

Var. *gabrielensis* De Gregorio. Pl. 20, figs. 14, 15. A little, very elegant, cylindric species, mammillate, having a strongly developed tooth on the columellar lip, properly speaking; it is mainly from this character that I have proposed this variety. Sargente del Gabriele near Palermo; beech woods of Madonie and S. Ciro near Palermo (*Pupa muscorum* L. Müll. var. *gabrielensis* De Gregorio, Il Nat. Sicil., xiv, Sept. 1895, p. 205; referring to Benoit's figures of *Pupa muscorum*, Ill. sist. crit. icon. test. estramar. Sicilia, pl. 5, f. 41). Benoit's figures are copied and De Gregorio's description translated. It is probably of no racial value, merely a Sicilian "*unidentata*" or mut. *marginata*.

8. Pupilla aucapitainiana (Bgt.). Pl. 20, figs. 18, 19.

Shell minute, deeply and very narrowly umbilicate, globuose or ventricosely suboblong, thin, fragile, glossy, pellucid, smooth, pale corneous or slightly greenish corneous. Spire obese, at the apex obtuse. Whorls 5½ to 6, convex, regularly, slowly increasing, separated by an impressed suture; the last whorl a little larger, rounded at base, straightened at the in-

sertion of the outer margin and lightly dilated near the aperture. Aperture a little oblique, semiovate; peristome white-thickened, fragile, a little expanded throughout, the margins approaching. Length 3, diam. 2 mm. (*Bgt.*).

Algeria: Forest of Edough, near Bone, at the foot of trees, under moss and dead leaves (*Letourneux*).

Pupa aucapitainiana Bourguignat, Malac. de l'Algérie, ii, 1864, p. 93, pl. 6, f. 17-19.

9. Pupilla bigranata (Rossm.). Pl. 20, figs. 22, 23.

Shell very small, very narrowly perforate, oval-cylindric, obtuse, brown, rather smooth, without luster, thin, somewhat translucent. Aperture half-ovate. Peristome with separated insertions, with a very narrowly reflected border, the neck behind it at first contracted, then encircled with a callous ring. A small tooth on the parietal wall and one in the palate. Length 1½, width ¾ lines; whorls 6 to 7 (*Rossmaessler*).

Germany: Hönningen am Rhein; old Middle-Pleistocene sand of Mosbach and young Middle-Pleistocene loess of Schierstein (Boettger); loess near Wiesbaden (Roemer), and of Selki im Kreis Poltawa, Russia (Bttg.).

Pupa bigranata Rossmaessler, Iconographie Land u. Süssw.-Moll., ii, 1839, p. 27, pl. 49, f. 645.—*Pupilla bigranata* (Rssm.) Boettger, Jahrb. Nassau. Ver. Naturk., 42, 1889, p. 261.

Decidedly smaller than *P. marginata* [= *muscorum*] and further differing by the invariable palatal tooth, otherwise very closely related (*Rossmaessler*).

Boettger remarks that it is separated from *P. cupa*, which is of the same size, by the flatter whorls and the weaker striation of the shell. As *P. cupa* appears hitherto to have been found in alpine and subalpine, *P. bigranata* only in level districts, it might not be amiss to comprehend both as synonymous. But he gives warning that Rossmaessler's shell is not to be confused with the var. *masclaryana* Pal. of *P. muscorum*, which also has parietal and palatal teeth, but is always of the size of *muscorum*.

The status of *bigranata* cannot be considered settled, but for the purpose of this work Boettger's view is accepted.

10. PUPILLA ALPICOLA (Charpentier). Pl. 21, figs. 16 to 18.

A little larger than the preceding [*P. marginata* Drap., *muscorum* auct.]. Very rare. Mont Gédroz, Vallée de Bagne (Charp.).

Switzerland: Mont Gédroz, Vallée de Bagne (Charp.); Tour de Bavon, Valais, 2450-2481 meters (Piaget).

Pupa alpicola CHARP., Cat. Moll. Swisse, Nouv. Mém. Soc. Helvet. Sci. Nat., i, 1837, p. 16, pl. 2, f. 5.—? KUESTER, Syst. Conchyl. Cab., Pupa, 1848, p. 102, pl. 14, f. 3-5. PFR., Monogr., ii, 305).—*Pupilla alpicola* Ch., PIAGET, Revue Suisse de Zool., xxi, June 1913, p. 473, pl. 14, f. 20.

Pupa muscorum var. *madida* GREDLER, Tirol's Land- und Süsswasser-Conchylien, Verh. zool.-bot. Ver. in Wien, vi, 1856, p. 113. — KOBELT in Iconographie (2), viii, p. 80, pl. 233, f. 1507. — [*Pupa*] *madiola* WESTERLUND, Fauna, 1887, p. 124 (typog. err.).

Closely related to *P. cupa*. According to Clessin, his *Pupa muscorum* var. *pratensis* is equal to *madida*.

Westerlund (Nachrbl., 1875, p. 73; Fauna, 1887, p. 123) considers *alpicola* to be a variety of *P. sterri*. Clessin admits this for Kuester's figures, but thinks Charpentier's shell is *madida* Gredler. Piaget also takes this view, giving a new figure of *alpicola*, our pl. 21, fig. 18. Charpentier's original figures are reproduced, a little enlarged by photography, in pl. 21, figs. 16, 17.

P. alpicola saxetana Piaget. Pl. 21, figs. 14, 15. Shell with a quite long umbilical crevice, dilated at its margin, finely and regularly striate, a little more than in the type, very short and wide, very ventricose, oval-cylindric, with very little gloss, brown; summit very much rounded. Only 5 whorls, very convex, increasing more rapidly than in the type, the suture deep. Aperture quite large, normal in shape, rounded. Peristome lightly margined with white within, quite thin; columellar margin little oblique, narrow, better margined

than the others; without an external crest. One very small, inconspicuous parietal tooth often wanting.

Differs from the type by the very short, wide, strongly swollen shell; minutely striate. Suture and denticulation normal. Whorls 5, strongly convex. Length 2.25 to 2.75, width 1.5 to 1.75 mm. Alps: margins of the lac des Veaus and some examples at the summit of the col between Montgond and Mont-gelé (Valais), 2550-2735 meters (*Pupilla alpicola* var. *saxetana* Piaget, Malacologie Alpestre, in Revue Suisse de Zool., xxi, June 1913, p. 496, pl. 14, f. 21, 22.

The description follows of [*Pupa muscorum*] var. *madida* Gredler (pl. 21, figs. 21, 22, after Kobelt). — Shell much broader with the usual or even smaller length, thinner shelled, more cylindric, with blunter summit and more convex whorls; umbilical cavity wider; cervical callus inconspicuous, colored like the rest of the shell; peristome not lipped, the aperture thereby larger; anteriorly in the palate a rudimentary, punctiform tooth; the margins of the peristome somewhat approaching (*Gredler*).

Austrian Tyrol: Salten bei Botzen, 5000 ft. elevation, on moss at the border of a meadow spring, type loc.

11. PUPILLA HONESTA (Westerlund).

Shell rimate-umbilicate, cylindric, with rounded apex, densely, regularly striatulate, tawny or whitish; whorls 7-7½, convex, slowly increasing, the last provided with a thin longitudinal sulcus below the middle, posteriorly abruptly descending, horizontal below, compressed, anteriorly dilated, surrounded with a narrow, transverse, whitish callus, above slowly but strongly ascending; suture impressed. Aperture small, suboval, 3-toothed, 1 parietal within, 1 deeply placed columellar, nodiform and sometimes obsolete, 1 pliciform palatal, elongate behind the base; peristome thickened, margins joined by a callus, thickened nodule-like at the external insertion. Length 4, diam. 2 mm. (*West.*).

Italy (Parreyss).

Pupa (Pupilla) honesta WESTERLUND, Nachrbl. D. M. Ges., xxiv, December, 1892, p. 194.

"Related to *P. sterri* Voith."

12. PUPILLA HALLERIANA (Charp.).

Shell shortly rimate, oblong-cylindric, obtuse at apex, striatulate, under a lens most minutely granulate, rather shining, reddish-corneous; whorls 7, a little convex, regularly increasing, the last with a short, obtuse basal crest, outwardly marked with a scar, compressed, encircled with a narrow callus of the color of the shell (not whitish) before the semioval, toothless aperture; peristome a little reflected, without an internal callus joining the margins. Alt. 3-3½, diam. 2-2½ (*Charp.*).

Switzerland: in marshy meadows, Tedunum, Saxon, Octodurum, Roche; not far from the home of the great Haller himself (Mousson, Venetz, Charpentier); under stones and at the roots of grass in wet meadows at Vish, Chable and another place in the Vallée de Bagnes. 1250 to 2500 ft. elevation (Jeffreys).

Pupa halleriana CHARPENTIER in Jeffreys, Ann. Mag. N. H. (2), xv, Jan. 1855, p. 27.

It differs from *P. cupa* by the very minutely granulose shell, not simply striatulate; last whorl is obtusely and shortly compressed at base, aperture constantly toothless in more than 100 specimens seen, without a parietal fold, semioval, not rounded-trigonal, and the margins are not connected by a callus. From *P. marginata* var. *edentula* [*P. muscorum*] it is easily distinguished by the slightly larger size, the shell more contracted, callus behind the aperture narrower, colored like the shell, not whitish, and by the scrobiculation at the cervical callus at base. That species inhabits dry, *P. halleriana* marshy places (*Charp.*).

Thought by Boettger, with good reason, to be a form of *madida* (*alpicola*), but Westerlund dissents. Not identified since its description, though it appears from the original account to be somewhat common. No specimens are contained in the Jeffreys' collection.

13. PUPILLA CUPA (Jan). Pl. 23, figs. 1 to 4.

Shell small, rimate, cylindric with very obtuse summit, finely but regularly striate, having a satin luster, thin, red-

dish brown, translucent. 6-7 convex, very slowly increasing whorls separated by a deep suture, the last somewhat compressed below, with arched neck, rapidly ascending in front, broadly contracted behind the peristome and encircled with a sharp, whitish crest. Aperture roundish, relatively small, yellowish flesh-colored, lipped within, generally 3-toothed, with one tooth on the parietal wall, a strong one on the columella and one in the palate; the latter sometimes consists of two tubercles, showing through outside, connected by a whitish lamella. Frequently it is wanting entirely; also the columellar tooth often is lacking, and even the parietal. The peristome is nearly unexpanded, sharp, the outer margin rounded. Length 3, diam. 1.5 mm. (*Kobelt*).

Near and in the Bavarian and Tyrolese Alps, Württemberg; Piedmont, Switzerland; according to Westerlund also in the Tatra, in Galizia; a variety in Transcaspia and northwestern China.

Pupa cupa Jan, Mantissa, 1820, p. 3.—Pfr., Mon. Hel. Viv., ii, p. 327. — Kuester, Syst. Conchyl. Cab., Pupa, p. 122, pl. 16, f. 6-8. — Clessin, Fauna Oesterreich-Ungarns, p. 257, f. 158.—Kobelt, in Rm., Iconographie Land u. Süsswasser. Moll. (2), viii, 1889, p. 80, pl. 233, f. 1506, 1509.

Pupa sterrii von Voith in Fuernrohr's Naturhist. u. Topographie von Regensburg, 1838, p. 409 (Abach near Regensburg).—Pfr., Monogr., ii, p. 313.—Clessin, Excursions moll. (2), p. 246, f. 141. — Boettger, Nachrbl. D. Mal. Ges., 1884, p. 48. — Westerlund, Fauna, 1887, iii, p. 122. — Kolasius, Nachrbl. D. M. Ges., 49, 1917, p. 37 (distribution in Germany).—Clessin, Berichte Naturwiss. Vereines Regensburg, xiii, 1911-12, p. 82 (1912; reprint of orig. descr. of *P. sterri*). —*Pupa (Pupilla) sterri* v. Voith, Geyer, Jabresh. Ver. vaterl. naturkunde Württemberg, lxiii, 1907, p. 422 (habits and dist. in Germany). — *Pupa steerii* Kuester, Syst. Conch. Cab., *Pupa*, p. 14, pl. 2, f. 5, 6.—*Pupa aridula* Held, Kuester, t. c., p. 14, pl. 2, f. 8-10 (Bavaria: auf Anhöhen an trocknen Felsen bei Eichstädt, Regensburg, spärlich auch unweit München: Held).—Pfr., Monogr., ii, 312.

From its two nearest relatives, *P. muscorum* and *P. tripli-*

cata, it differs by the stronger striation; in stature it stands between them (*Kobelt*).

D. Geyer, who has collected the species in many places in Württemberg and Bavaria, notes that it is a limestone and warmth-loving species and prefers Jura cliffs upon which the rays of the midday and afternoon sun fall unhindered. It does not crawl on the rocks but is restricted to the mould in ledges of disintegrating cliffs and the rhizomes of the cliff verdure, preferably grasses. If one would collect them he must pull up the plants and sieve the fine black earth.

Figures of the synonymous *Pupa sterrii* (pl. 23, fig. 5) and *P. aridula* (pl. 23, fig. 10) are reproduced from Kuester.

Var. *carpathica* Kim. The Transsylvanian form differs from that of western Europe in having the aperture constantly toothless, or at most and rarely the denticle on the parietal wall is scarcely indicated. Also the apertural callus is never more than moderately developed. Tordaer Felsspalte and other places (*Pupilla cupa* var. *carpathica* Kimakowicz, Verh. u. Mittheil. Siebenbürg. Ver. nat. in Hermannstadt, xl, 1890, p. 108).

Var. *emigrata* West. Shell thin, brown, without vestige of a cervical callus; aperture semirotund, entirely toothless; peristome thin, simple, straight. Length 3, diam. 1⅔ mm. Mt. Pindus, Greece (*Pupilla cupa* var. *emigrata* Westerlund, Synops. Moll. Extramar. Reg. Palaearc., i, 1897, p. 107).

Var. *turkestanica* West. Shell of the size of *P. muscorum*, widely perforate, cylindric, corneous, obsoletely striatulate. Whorls 6½, regular, the last longer, double the alt. of the penult, ascending for a long distance, at the aperture with a white swelling in place of the callus, flattened towards the base, posteriorly straightly sloping; aperture lipped, with a high, deeply placed parietal lamella, a small conic tooth on the columella, and one palatal fold, elongate, short or tuberculiform; margins distant, the outer strongly, subrectangularly arcuate above. Length 3, diam. 1⅔ to 2 mm. Turkestan. There is a variety entirely toothless or with a parietal denticle (*Pupilla cupa* var. *turkestanica* Westerlund, Synops., 1897, p. 108).

The cylindric stature, the deep suture, the great convexity of the regularly striate whorls, the form of the umbilical perforation and the aperture are entirely those of *P. cupa* Jan; only the denticulation is evidently weaker; out of 10 specimens from the Agh-dagh 7 are toothless and only 3 have a rather weak parietal tooth, but neither columellar (which appears to be exceptional in the typical form) nor palatal teeth (*Boettger*).

Andreae remarks that "it is chiefly distinguished from the type by the degeneration or lack of teeth. We see in this character a repetition of the similar characteristic of the Asiatic *P. muscorum*." He reports it from the Küke-nur region and many places in Thibet and western China, chiefly in loess.

P. cupa turcmenia Boettger. Pl. 23, figs. 6 to 9. Differs from the type by the thinner shell, the last whorl little ascending, the margins of the aperture less enlarged, either toothless or provided with only a small parietal tooth. Alt. 3-3⅛, diam in the middle 1⅝ mm. (*Bttg.*).

Transcaspia, on the peak of Agh-dagh in Kopet-dagh, 9,000-10,000 ft. above the sea, abundant (Dr. A. Walter); débris of the Juldus on the southern spur of the Thian-shan in N. W. China, in large numbers; loess of Prov. Kan-su; Thibet.

Pupilla cupa var. *turcmenia* Boettger, Zool. Jahrbücher, Abth. f. Syst. etc., iv, 27th Dec., 1889, p. 958, pl. 26, f. 3a-c.—*Pupa (Pupilla) cupa* Jan var. *turcmenia* Boettger in sched., Andreae, Land- und Süsswasserschnecken aus Zentral- und Ost-Asien, p. 71, f. ii, in Futterer's Durch Asien, iii, 1911; Mittheil Römer-Museum, Hildesheim, no. 11, April, 1900, p. 11, f. ii (Loess of Kumbun, Kan-su).

The figures of Boettger, representing recent specimens (figs. 8, 9) and of Andreae showing those of the Chinese loess (figs. 6, 7) are reproduced.

14. Pupilla (?) neumeyeri (Küster). Pl. 20, fig. 24.

Shell small, umbilicate, obtuse, ovate-cylindric, of few whorls, opaque, pale corneous, subdiaphanous; whorls rather

flat, narrow, the suture rather deep. Aperture oblique, ovate; parietal wall one-toothed. Length 1½, diam. 1 line; 7 whorls.

Dalmatia: crevices of cliffs of the island Lissa.

Pupa neumeyeri KUESTER, Syst. Conch. Cab., *Pupa*, 1848, p. 56, pl. 7, f. 15, 16.

Küster remarks that it is related to *P. muscorum* in shape, but somewhat less blunt, and easily distinguished by the peculiarly formed aperture. It is very finely, almost inconspicuously striate. The 7 whorls are nearly flat, the last strongly contracting below. The rounded parietal tooth is fold-like; peristome straight, hardly thickened; a strong callus on the neck.

The figure looks like a *Lauria* rather than *Pupilla*. It is a lost species, known only by the original account.

15. PUPILLA TRIPLICATA (Studer). Pl. 21, figs. 11, 12, 13.

The shell is dextral, much smaller than *P. muscorum*, with a very minute, round perforation; cylindric with very blunt summit, smooth or hardly visibly striate, cinnamon-colored, thin, with some luster. 6 to 7 very slowly increasing whorls, moderately convex, with rather deeply impressed suture, the last half-whorl flattened, usually impressed over the lower-palatal fold, having a high, rounded crest behind the lip, followed by a deep, narrow constriction. The aperture is truncate-rounded, armed some distance within with three teeth: a deeply entering parietal lamella, its inner half low, a nodular columellar lamella, and a rather long lower-palatal fold, tapering inwardly. The peristome has a thin, narrow reflection and is but little thickened within, the margins converging.

Length 2.8, diam. 1.45 mm.; 6⅓ whorls. Switzerland.

Length 2.8, diam. 1.3 mm.; 6½ whorls. Mt. Roland (Jura).

Length 2.3, diam. 1.3 mm.; 5¾ whorls. Mt. Roland (Jura).

Length 2.95, diam. 1.45 mm.; 6½ whorls. Lyons.

Throughout the mountain regions of southern Europe from the Pyrenees to the Caucasus.

Pupa triplicata STUDER, Kurzes Verzeichniss der bis jetzt in unserem Vaterlande entdeckten Conchylien, in Naturwissenschaftlicher Anzeiger der allg. Schweiz. Ges. gesammten

Naturwissenschaften, May 1820, p. 89 (Bexvieux, also around Bern). — Charpentier, Cat. Moll. Suisse, Nouv. Mem. Soc. Helvet. des Sci. Nat., i, 1837, p. 16, pl. 2, f. 6.—Kuester, Syst. Conch. Cab., *Pupa*, p. 15, pl. 2, f. 11, 12. — Moquin-Tandon, Moll. France, ii, p. 395, pl. 28, f. 16-19. — Pfr., Monogr., ii, 354; iv, 678.—Westerlund, Fauna Europæa Moll. extramar. Prodromus, ii, 1878, p. 183, with var. *edentata, unidentata, bidentata, tridentata;* Fauna, 1887, p. 123. — Bourguignat, Moll. Gr. Chartreuse, 1864, pl. 8, f. 9-12. — *Pupa (Pupilla) triplicata* Stud., Boettger, Jahrb. D. Malak. Ges., vi, 1879, pp. 26, 400 (Caucasus localities and forms). — Kobelt, Rossmaessler's Iconographie (2), viii, p. 78, pl. 233, f. 1504, right and left figs.

Pupa tridentalis Michaud, Complément de l'hist. nat. moll. terr. et fluv. France de Drap., 1831, p. 61, pl. 15, f. 28-30.

P. triplicata is smaller than *P. muscorum,* with the parietal and palatal teeth longer, the lip-rib further within, and usually having a well-developed columellar tooth.

Westerlund divided it into 4 varieties: "1, *edentata;* 2, *unidentata,* on the parietal wall; 3, *bidentata,* on parietal and palatal walls; 4, *tridentata.*" He afterwards abandoned these varieties; the names of the first three are preoccupied, and no localities were assigned for any of them.

Several forms have been described in which the columellar tooth is lacking (*striatissa, esinensis, bibaca*); and in *luxurians* there is an additional tooth, the upper palatal. These are forms of the eastern Alps and Caucasus. Elsewhere there is variation in length of the shell, but less in the teeth.

Mut. *tardyana* 'Bgt.' Locard. Ovoid-conic, short and stout; 6 quite convex whorls, the suture quite deep; umbilicus quite open; aperture relatively quite large, well rounded, oblique; 3 folds disposed as in *triplicata* but stronger; shell reddish-fawn, ornamented with very delicate striæ. Alt. 2½, diam. 1½ mm. Very rare; environs of Salins (Jura). (*Pupilla tardyana* Brgt. in coll., Locard, Ann. d'Agricult. Lyon, (7), iii, p. 218; Conchyl. Fr., 1894, p. 330.) Probably mere stunted individuals. The name has also appeared as *Pupilla tardiana* (B.) Loc., in Westerlund, Synopsis, 1897, p. 109.

Var. *pyrenaica* West. Shell small, oval-cylindric; whorls

5-5½, narrow, convex, the last convex at the sharp cervical callus, the neck not depressed or sulcate below; base rounded; aperture with a single very obsolete denticle outwardly in the middle of the palate below the lip. Length 2¼, diam. 1½ mm. Pyrenees Orientales (*Pupilla triplicata* var. *pyrenaica* Westerlund, Synopsis, 1897, p. 108).

Var. *monodon* Bielz. This form is removed from *P. triplicata* a step further than *P. bigranata* Rossm., as in it only the tooth on the parietal wall remains, and therefore stands between the latter and *P. dilucida* Zgl. On the limestone cliffs of Kecskeko at Krakko. (*Pupa triplicata* var. *monodon* Bielz, Verh. u. Mittheil Siebenb. Ver. Naturwiss. Hermannstadt, iv, June, 1853, p. 119.)

Kimakowitz (Verh. u. Mittheil. Siebenbürg. Ver. Naturwiss. Hermannstadt, xl, 1890, p. 108) is in doubt whether this belongs to *P. triplicata* or *P. cupa*, as its locality lies within the range of both. As the name was previously used by Held, the identity of Bielz's form is of only academic interest.

P. triplicata esinensis (Pini). Differs from the type by having the columellar tooth obliterated and the palatal fold long. Monte S. Defendente near Esino, Lombardy (*Pupa triplicata* Stud. var. *esinensis* Pini, Atti Soc. Ital. Sci. Nat., xxvii, 1884, p. 380).

P. triplicata striatissa (Gredler). With the slender shape and dentition of *bigranata*, and like that, without the impression corresponding to the long palatal fold, darker colored and much more distinctly striate. Tschaffon Mountain, not far from Botzen, Tyrol, at 4800 ft., in company with *P. triplicata* on grassy limestone rocks (Gredler, Verh. zool.-bot. Ver. in Wien, vi, 1856, p. 111). Gredler adds that there are also transitions to the typical form, in which one or another of the teeth is incompletely developed; especially the columellar tooth may be only a callus, or so deep that it can be seen only in an oblique view; the last being found in Eisacktal and Etschtal.

P. triplicata bibaca Kim. More ovate, usually more solid, darker colored, with the columellar tooth constantly wanting. This is the form of the plains and hill country, which lives not only on limestone but also on mortar. In Transsylvania

I collected it in the Tordaer Felsspalte with *P. muscorum* and *P. cupa*. Dr. Wagner took it on the Friedhofsmauer Marktschelkens im Kokelthal. A larger form of the same was taken by Jetschin in the Schlosspark von Ahrenfels bei Hönningen near Neuwied in the Rheinprovinz (*Pupilla triplicata* Stud. var. *bibaca* Kimakowicz, Verh. u. Mittheil. Siebenbürg. Ver. Nat. in Hermannstadt, xl, 1890, p. 107).

P. triplicata suboviformis Boettger. There is a three-toothed form represented by 7 examples, which I can distinguish from my Tyrolese specimens of *P. triplicata* Stud. only by the diminished size, about 2 mm. long, nearly 1½ broad, and by the more ovate than cylindric shell. It comes from Mamudly in Transcaucasia. I agree entirely with O. Reinhardt in his identification of Mousson's *P. signata* var. *parvula* with this or some very closely related form of *P. triplicata* (*Pupa (Pupilla) triplicata* Stud. var. *suboviformis* Boettger, Jahrb. D. Malak. Ges., vii, 1879, p. 26).

Pupa signata var. *parvula* Mousson, Journ. de Conch., xxiv, 1876, p. 39 (not *Pupa parvula* Desh., 1864), is described thus: Smaller, 1½-2 mm., thinner, less labiate, palatal tooth depressed, sometimes accompanied by another obsolete one, columella deeply and minutely subnodulose. Borschom, Transcaucasia.

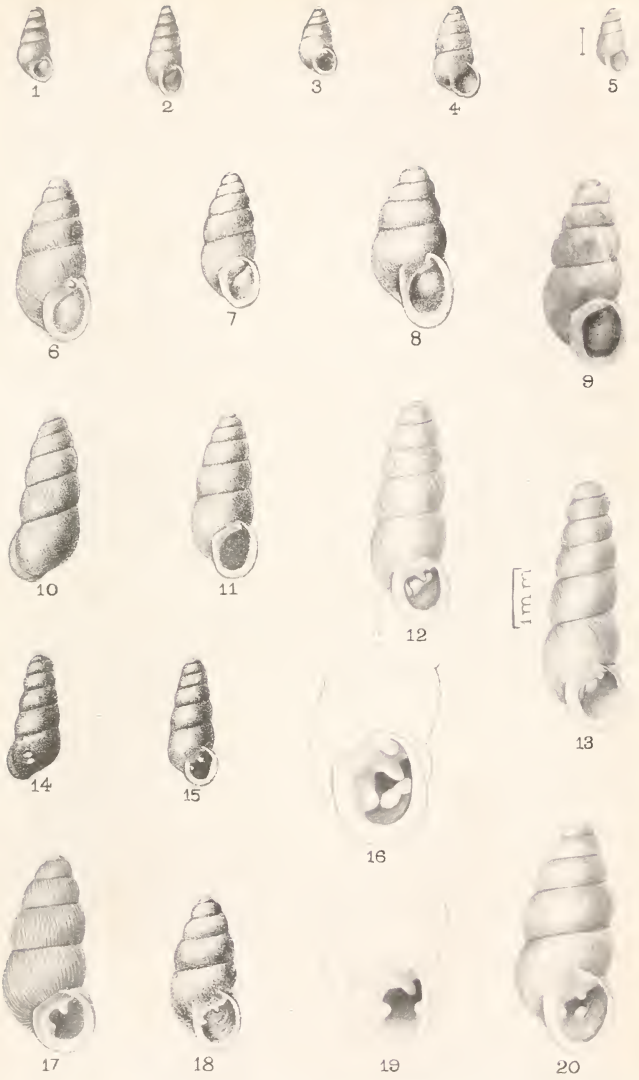
P. triplicata luxurians (Reinh.). Pl. 21, figs. 19, 20. With two palatal folds. Borschom, Transcaucasus (Reinhardt, Jahrb. D. Malak. Ges., iv, 1877, p. 79, pl. 3, f. 2.—Boettger, Jahrb., vi, 26; vii, 137.

III. Asiatic Species.

Besides the following species, *P. muscorum*, no. 7, and *P. cupa*, no. 13, are widely distributed in northern Asia. *P. poltavica* occurs in European Russia, and various forms of *P. signata* in the Caucasus.

Series of P. signata (Section *Primipupilla*).

In this group the lip is usually broad; typically the angular, parietal, columellar and two palatal teeth are present, but there has been reduction in some species, the palatals and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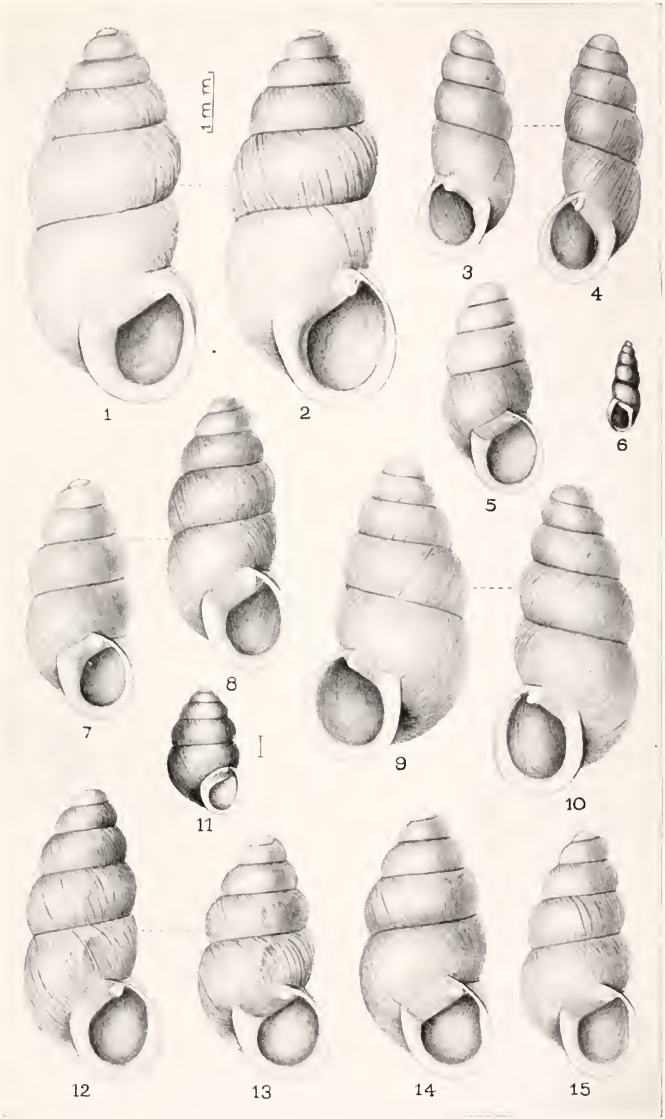
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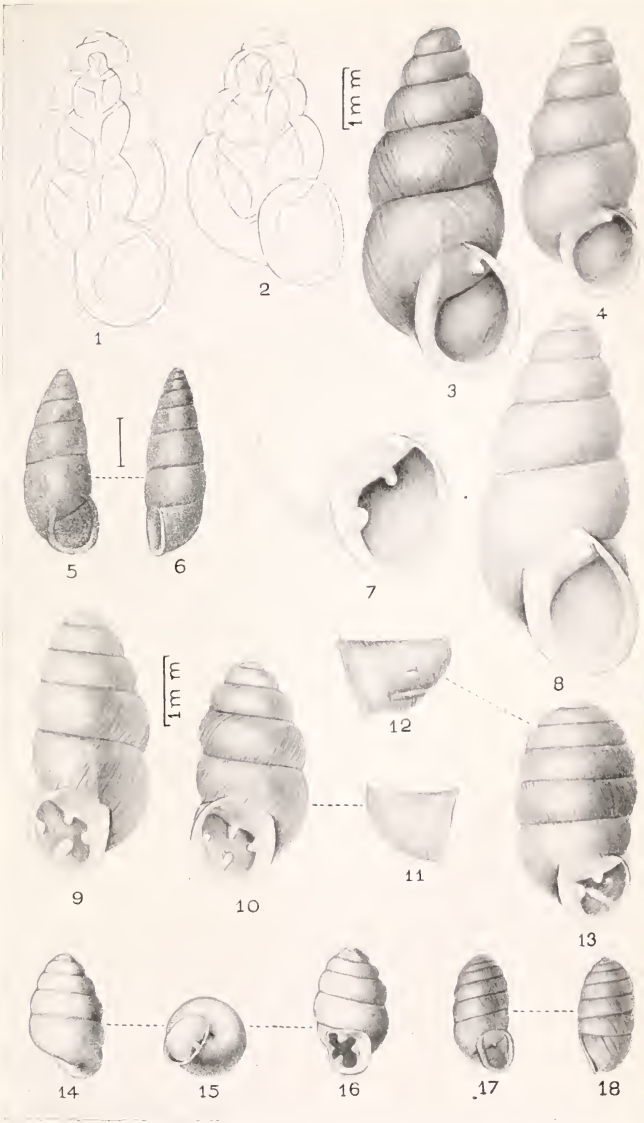
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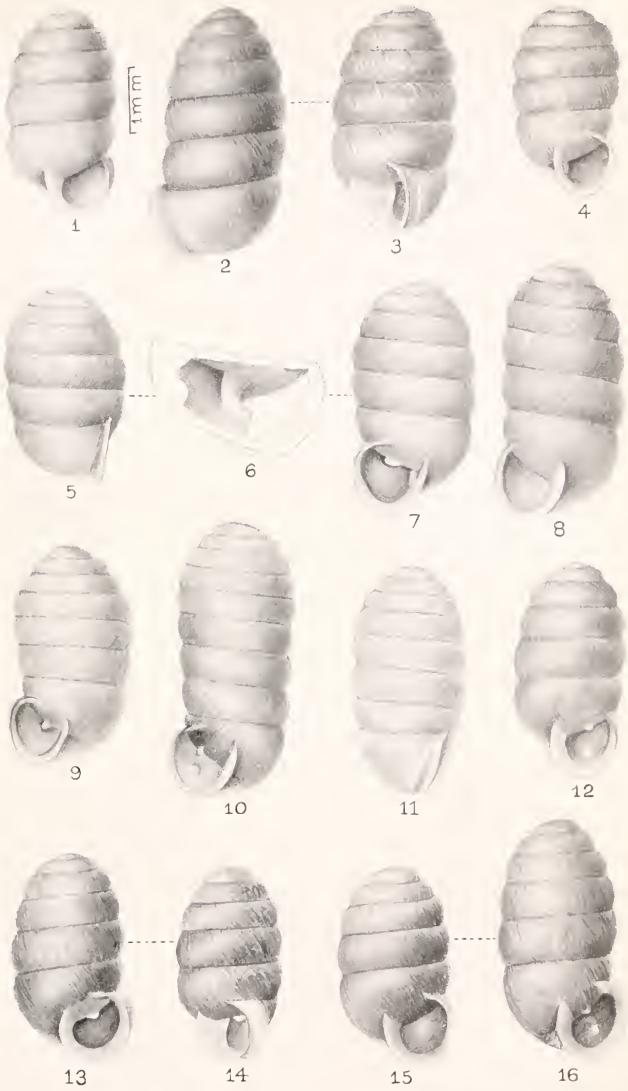
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sometimes the angular dropping out. The embryonic whorls are closely, shallowly pitted, producing an irregular reticulation of raised wrinkles, coarser than in the *muscorum* group.

16. Pupilla armeniaca (Issel). Pl. 22, figs. 16, 17.

Shell deeply rimate, ovate-cylindric, obtuse, very delicately obliquely striate, tawny-corneous, not glossy; whorls 7, a little convex, slowly, regularly increasing, separated by an impressed suture; the last whorl more than one-fourth the total length, slightly ascending to the aperture, compressed around the perforation, carinate. Aperture small, regular, the parietal wall having a deeply placed denticle; peristome thickened, a little reflected, spreading; lateral margins subparallel. Length 3, diam. 1.5 mm. (*Issel*).

Armenia: Erivan (Prof. Filippi).

Pupa armeniaca Issel, Catalogo dei Molluschi raccolti dalla Missione Italiana in Persia, p. 39 (1865), in Mem. Reale Accad. Sci. Torino, (2), xxiii, p. 423, pl. 2, f. 45, 47.

No palatal teeth are mentioned. It probably belongs to the *P. signata* group.

17. Pupilla antinorii (Palad.). Pl. 21, fig. 4.

Shell broadly and deeply umbilicate, cylindric, slightly subovate, very finely striatulate, little shining, whitish-buff. Spire convex-conic, at the minute apex obtuse. Whorls 7½, little convex, rapidly increasing, especially from the third, separated by a not very deep suture; the last whorl strongly ascending at aperture, having two impressed scars behind, somewhat constricted at aperture; umbilicus surrounded with an indistinct keel; free margin convexly-subsinuous. Aperture subovate, wider above; parietal wall having a rather long tooth-like fold in the middle. Peristome expanded, reflected, the margins separated; outer margin a little arcuate, having a minute fold somewhat approaching the free end of the parietal tooth. One palatal fold, forming a shallow pit outside. Columella slightly arcuate, having a deeply immersed fold. Outer and inner margins strongly approaching by the incurving of the lips above. Length 4, diam. 2 mm. (*Palad.*).

Aden.

Pupa antinorii Paladilhe, Ann. Mus. Civ. Stor. Nat. Genova, iii, Dec., 1872, p. 21, pl. 1, f. 11, 12.

Compare *P. signata,* which must be closely allied, but in a quite different faunal zone.

18. PUPILLA SIGNATA (Mouss.). Pl. 21, figs. 1, 2, 3.

Shell minute, rimate-perforate, inflated-cylindric, rather solid; obliquely slightly striate, nearly smooth; pale corneous. Spire nearly equally coiled, rapidly decreasing; summit obtuse; suture a little impressed; whorls 7-8, rather convex, the first three rapidly enlarging, the rest subequal, the last a little ascending, small, rounded, towards the aperture obliquely swollen, then a little contracted, towards the base anteriorly obtusely crested and marked with an impression. Aperture rather small, vertical (6° with the axis), semicircular, strongly contracted; in the parietal wall one entering tooth, and another long one deep in the palate, corresponding to the external impression. Peristome white, broadly expanded, strongly and acutely lipped within, the margins remote, joined by a somewhat prominent layer; the right margin thin at the insertion, then subnodulose and thickened; columellar margin broadly spreading, toothless. Length 4, diam. 2 mm. (*Mouss.*).

Turkestan, widely distributed; Transcaspia, Northern Persia, many localities in Armenia and Transcaucasus; Samarkand and Iskander-kul in the Sarafshan headwaters; foothills of the Thianshan. Bograhat and Sass-tekke (Pasrobat anad Sasak-Taka), west of Yarkand. Type locality "les alluvions de l'Araxe."

Pupa signata MOUSSON, Journ. de Conch., xxi, 1873, p. 211, pl. 8, f. 7; xxiv, 1876, p. 143, var. *parvula* and *cylindrica.*—MARTENS, Central Asiat. Moll., Mém. Acad. St.-Pétersb. (7), xxx, no. 11, 1882, p. 28.—E. A. SMITH, Journ. Linn. Soc. Lond., xxvii, 1899, p. 393 (Koyun Daghi, Persia).

Pupa (Pupilla) signata Mouss., BOETTGER, Jahrb. D. M. Ges., vi, 1879, pp. 399, 401; vii, 1880, p. 137 (Caucasus; with f. *albina,* Tiflis).—*Pupilla signata* (Mouss.), BOETTGER, Zool.

Jahrb., iv, 1889, p. 959. — KOBELT, Iconographie (2), viii, p. 87, pl. 233, f. 1521. — *Pupa cristata* v. MARTENS, in Fedtschenko's Reise in Turkestan, Mollusca, 1874, p. 23, pl. 2, f. 19 (shell), pl. 3, f. 40 (jaw and teeth). — NEVILL, Handlist Moll. Ind. Mus., i, 1878, p. 191; Second Yarkand Mission, Mollusca, p. 5.

Typically this large species has five teeth, an angular, parietal, columellar and two palatals; but as in other Pupillas, some of them are often wanting. The cylindric shape, numerous narrow whorls and broadly reflected white lip are more constant characters.

Var. *cylindrica* Mouss. Cylindric; whorls 8-9; peristome frequently continuous, the columella deeply subnodulose. Krasnowodsk. (*Mouss.*).

Var. *cyclostoma* West. Shell similar to var. *cristata* Mts., but white, hyaline, densely, regularly striate; aperture circular, peristome continuous in a high parietal lamina; whorls very convex, parted by an impressed suture. Persia at Scharud, O. Herz [*Pupa* (*Pupilla*) *signata* Mss. var. *cyclostoma* Westerlund, Nachrbl. D. M. Ges., Aug. 1893, p. 121].

Var. *debilis* West. Shell corneous, nearly smooth, whorls a little convex; suture thin; margins of the aperture widely separated, without trace of a callus; a very minute, tuberculiform tooth deep in the palate; peristome very narrowly reflected; last whorl strongly whitish-calloused anteriorly, externally very obsoletely impressed, the base lightly crested. Caucasus at Krassnowordsk, O. Retowski [*Pupa* (*Pupilla*) *signata* Mss. var. *debilis* West., *op. cit.*, p. 121].

The original description of *Pupa cristata* Martens follows.

Pupa cristata. Pl. 21, fig. 3. — Shell rimate, cylindric-ovate, obliquely striatulate, pale brown, a little shining, obtuse at apex. Whorls 7, the first three forming an obtuse cone; fourth, fifth and sixth of equal width, slowly increasing in height, the last a little narrowed, subcompressed at base, *provided with an obtuse umbilical keel*, strongly ascending in front and towards the aperture, having a somewhat *prominent transverse crest parallel with the outer margin, then constricted.* Aperture small, semirotund, the peristome reflected throughout, somewhat thickened, pale brown, the margin insertions remote, joined by a thin callus, outer mar-

gin arcuate, columellar perpendicular, basal rounded; parietal wall with a short denticle at the insertion of the outer margin and a deeper, stronger median fold; columella one-folded; two palatal folds, the lower longer and stronger. Length 3⅔, diam. 1¾ mm.; aperture scarcely over 1 mm. long and wide (*Martens*).

Turkestan: in the Sarafshan valley near Maracandam, Piandjikent and Magian (Fedtschenko).

19. PUPILLA DIECKI (Gredler).

Shell narrowly umbilicate, as though rimate, cylindric, obtusely conic at the apex, densely and regularly striatulate, corneous, silky. Whorls 7-7½, but little increasing, convex. Aperture rounded, small, with two palatal folds and one strong, immersed parietal, the parietal callus obstructed with a punctiform fold at the outer insertion. Columella armed with a tooth-like callus. Peristome broadly expanded and flattened, slightly lipped, continuous, adnate parietally, the margin acute, fragile, the neck ornamented with a rather obtuse crest, behind and parallel to the margin. Length 3½, diam. 1⅓ mm.

Eastern Turkestan: Kulab (Dr. Georg Dieck).

Pupa diecki GREDLER, Nachrbl. D. M. Ges., xxi, 1889, p. 162.

This appears to stand in the group of *P. signata*, which Gredler does not mention in his comparisons; it is a smaller shell than that, yet requires comparison.

20. PUPILLA INTERRUPTA (Reinhardt). Pl. 21, figs. 5 to 8.

Shell dextral, conic-cylindric, rimate-perforate, rather glossy, slightly striate, pale corneous. Whorls 6½, slowly increasing, convex; the last ascending in front, somewhat compressed at the base, provided with a sulcus parallel with the suture; at the aperture transversely crested, then constricted. Aperture vertical, rounded, the peristome reflected, broadly white-lipped, margins converging, joined by a thin callus; right margin subangular above, thin at the insertion and also provided with a slightly prominent tooth and thickened; basal margin rounded; columellar straight and subperpendicular; one lamelliform parietal fold interrupted in the middle (pl. 21, fig. 5*a*), another strong, deeply placed columellar, and

two palatals, the lower corresponding to the external sulcus, the upper smaller. Length 3, diam. 1.5, aperture 1 mm. alt. and width (*Reinh.*).

Transcaucasus: Borschom, on the upper Kur, O. Schneider.

P.[*upa*] *interrupta* Reinh., Jahrb. D. Malak. Ges., iii, p. 367; iv, 1877, p. 79, pl. 3, f. 4. — *Pupa (Pupilla) interrupta* Boettger, Jahrb., vi, 1879, p. 403; vii, 137, Tiflis, with f. *albina*.

21. Pupilla poltavica Bttg. Pl. 21, figs. 9, 10.

Shell of the size of *P. triplicata* (Stud.), perforate, cylindric-ovate, short, wide. Spire convexly conic, the apex a little acute. Whorls 5½, slowly increasing, convex, separated by a well-impressed suture, regularly and closely costulate-striate, the last very slightly ascending, somewhat compressed at the base, encircled by a distinct but narrow anteperistomial callus. Aperture irregularly ovate, wider than high, the base receding. A small angular fold within the right margin, scarcely separated from the punctiform parietal, otherwise toothless. Peristome narrowly expanded, slightly thickened within. Length 2⅝, diam. in the middle 1⅝, alt. aperture ⅞, width 1 mm. (*Bttg.*).

Russia: Middle Pleistocene marl-clay of Kamenka, Circle of Poltawa, very rare, with typical *P. muscorum* (Prof. Dokutschajew).

Pupilla poltavica Boettger, Jahrb. Nassau. Ver. Naturk., 42, 1889, p. 262, pl. 6, f. 7.

On account of the peculiar structure and position of the angular and parietal lamellæ, both brought forward and situated near the right angle of the aperture, this form cannot be brought into close relation with any of the known living or fossil species of the genus; but *P. interrupta* Reinh. of Transcaucasus affords an analogy, inasmuch as in it also the anterior part of the parietal lamella can be interpreted as an angular. The palatal teeth and columellar tooth of the Transcaucasian species are wanting in the south Russian loess form here described (*Boettger*).

22. Pupilla chinensis (Hilber). Pl. 22, fig. 14.

The shell is very small, cylindric, having a very narrow, circular umbilicus, extremely finely striate, formed of 6 strongly convex whorls. The color of my specimen is glossy-brownish. The aperture is bluntly angular, continuous in a strong callus, having a white, strongly thickened peristome, reflected nearly to the upper margin. A strong parietal fold and tooth-like projections on the right wall of the aperture are present. The neck bears no trace of a fold. Alt. 3, greatest diam. 1.5 mm. (*Hilber*).

China: Lan-tchou-fu, Prov. Kan-su, one example in or on loess (v. Loczy).

Pupa (Pupilla) chinensis Hilber, SB. Math.-Nat. Cl. K. Akad. Wissensch. Wien, 88 Bd., 1 Abth., 1884, p. 1378, pl. 6, f. 11; repeated in Wissensch. Ergebn. Reise Szechenyi in Ostasien, ii, 1898, p. 618, pl. 4, f. 18.

Hilber's very inadequate figures of this and the following two species are reproduced photographically.

23. Pupilla richthofeni (Hilber). Pl. 22, fig. 15.

The shell is very small, cylindric, with a narrow umbilical crevice, extremely finely striate, consisting of 6 convex whorls. The color of my specimen is glossy yellowish-white. The aperture is truncate-oval, with a strong callus and with a strong, internally thickened, reflected margin. It has a very weak parietal fold, the indication of a tooth on the outer wall of the mouth, and a strong columellar tooth rather far within. On the neck there is a very weak callus. Alt. 3, greatest diam. 1.5 mm. (*Hilber*).

China: Hoi-njing-shien, Prov. Kan-su, from loess (Loczy).

Pupa (Pupilla) richthofeni Hilber, SB. Math.-Nat. Cl. K. Akad. Wissensch., Wien, 88 Bd., 1 Abth., 1884, p. 1379, pl. 6, f. 12; repeated in Wissensch. Ergebn. Reise Szechenyi in Ostasien, ii, 1898, p. 618, pl. 4, f. 19.

This species appears to me to stand near *P. triplicata* Studer. The most conspicuous difference is in the sharp peristome of the latter species. In examination the last whorl of the single specimen was broken; in restoring it the umbilical

region remained imperfect, hence only front view is given. The description was drawn up before the accident (*Hilber*).

24. PUPILLA AEOLI (Hilber). Pl. 22, fig. 13.

The shell is very small, cylindric, with a narrow, semicircular umbilicus, extremely finely striate, consisting of 6 whorls. The first two whorls of my specimen are blackish, the rest white. The aperture is rather circular, with a strong, internally thickened, reflected peristome. On the thin, hardly perceptible callus connecting the margins a strong tooth stands near the right margin; below this there is an inner parietal tooth beginning rather far from the other. About in the middle of the right margin there is a nodule on the inner lip, which corresponds to a weak concavity of the peristome. A distinct neck fold is present. Alt. 3.5, greatest diam. 1½ mm. (*Hilber*).

China: Hoj-njing-shien, Prov. Kan-su (Gan-su), one specimen from the loess of the mountain-side (v. Loczy). Santshuan, Ndami, Kloster Djoni and Tan-tshang, in the same Province (Mlldff.).

Pupa (Pupilla) aeoli HILBER, SB. Math.-Nat. Cl. K. Akad. Wissensch., Wien, 88 Bd., 1 Abth., 1884, p. 1377, pl. 6, f. 10; repeated in Wissensch. Engebn. Reise Szechenyi in Ostasien, ii, 1898, p. 617, pl. 4, f. 17. — *Pupilla aeoli* Hilber, Mlldff., Ann. Mus. Zool. Acad. Imp. Sci. St.-Pétersb., vi, 1901, p. 382.

P. aeoli terræ n. subsp. Pl. 22, figs. 6, 7. In the Gan-su specimen seen the lip is very broad. The angular lamella is represented by a rather low, transparent callous ridge running from the termination of the lip to the parietal lamella, which is high and strong. In a very oblique view in the mouth the columella appears weakly, obliquely truncate below, but without a tooth. There are no palatal folds, and only the weakest trace of a crest. The very fine striation is sharp and distinct on the intermediate whorls. Length 3.2, diam. above aperture 1.6 mm.; 6¼ whorls.

This is evidently the form commented on by von Moellendorff. It differs from *aeoli* as described by Hilber by the union of the angular and parietal lamellæ and the obsolescence of the crest; not characters of much importance in Pupilla.

It differs from *P. heudeana* by lacking palatal folds.

25. PUPILLA HEUDEANA (Mlldff.). Pl. 22, figs. 1 to 5.

Shell dextral, conic-cylindric, rimate-perforate, brown, most minutely but distinctly and regularly striatulate. Spire with subconic, obtuse apex. Whorls 6, flattened, joined by an impressed suture, subequal, the last subcarinate anteriorly around the umbilicus, subcompressed basally. Aperture vertical, rounded, somewhat sinuate at suture, the peristome reflected, expanded, thickened, the margins joined by a thin callus; right margin tapering to the insertion, having a strong tooth; columellar margin straight, a little expanded. One lamelliform parietal lamella excavated in the middle, another columellar, deeply placed and somewhat strong, two deeply placed, punctiform palatal folds. Length 3, diam. 1 mm. (*Mlldff.*).

China: In the old bed of the Hoang-ho near its former mouth into the Yellow Sea, near the town of Huai-an-fu, Prov. Kiang-su, under stones (P. Heude, type loc. of *P. cryptodon* and *P. heudeana*); Shanghai (Schmacker); Prov. Pechili at Shan-hai (Hirase). Prov. Shan-dung at Dshi-nan-fu (Möltner).

Korea: Seoul (Gottsche), Fusan (Hirase).

Japan: Mikage, Settsu (Hirase).

Pupa cryptodon HEUDE, Notes sur les Moll. Terr. de la Vallée du Fleuve Bleu, in Mém. concernant l'Hist. Nat. de l'Emp. Chinois, 1880, p. 77, pl. 18, f. 20 (not *Pupa cryptodus* Al. Braun, 1842).—*Pupa (Pupilla) heudeana* MOELLENDORFF, Jahrb. D. Malak. Ges., xi, 1884, p. 176.—GREDLER, Malak. Bl., n. F., ix, p. 145.—*Pupilla heudeana* MLLDFF., Ann. Mus. Zool. Acad. Imp. Sci. St.-Pétersb., vi, 1901, p. 381, with subsp. *grandis*.

In this widespread species of eastern China, Korea and Japan the angulo-parietal lamella is more or less interrupted or lobed, the outer lip has a projection or tooth below the sinulus, and there are two palatal folds, thereby differing from the closely related *P. aeoli* of northwestern China. It is quite variable in the considerable series seen.

The form figured by Heude under the preoccupied name *P. cryptodon* (represented in pl. 22, fig. 1, a topotype from Heude) has the mouth parts rather weakly developed. The internally thickened lip has a rather low but distinct projection near the upper third. The angular lamella does not reach to the angle of the mouth, and is only rather weakly connected with the stout, short parietal lamella; the connection being somewhat transparent, Heude described it as "dente parietali brevi, interrupto." The columellar tooth is a low, wide nodule. Palatal folds are quite small tubercles, rather near together. There is a very slight swelling a short distance behind the weakly expanded lip, but no crest or constriction. Length 3.3, diam. above aperture 1.6 mm.; 6¼ whorls.

Moellendorff's type of *heudeana* was a specimen from the same place, evidently having the apertural parts more fully developed, as he speaks of the lip-tooth as strong, and the parietal as "nur einfach gebuchtet." His measurements were doubtless roughly taken, and certainly wrong.

In shells from Shan-hai, Pe-chili, pl. 22, figs. 2, 3, the lip is strongly developed. The angular lamella reaches to the lip-end, and is weakly bilobed, being weakly continuous with the parietal lamella (fig. 3). All are quite low. The palatals remain small, the upper one sometimes wanting. Length 2.8, diam. above aperture 1.6 mm.; hardly 6 whorls. Also up to 3.15 mm. long. Specimens from Fusan, Korea, have also the trilobed angulo-parietal lamella, but the inner or parietal portion is much higher than in the Shan-hai shells. Length about 3 to 3.2 mm.

Japanese specimens, pl. 22, figs. 4, 5, Mikage, Settsu, have the angular and parietal lamellæ separate or nearly so, both more strongly developed than in any mainland forms seen; the parietal is much longer, the palatals and columellar well developed. Length 3.5, diam. 1.7 mm., of 7 whorls, to length 3.1 mm.

P. h. grandis Mlldff. Larger and somewhat thicker, 2 x 3.8 mm. Prov. Gan-su at Shan-tshuan, Djamba and Tshing-yüan.

Moellendorff states that Andreae's *Pupa signata,* as figured by him from localities in Gan-su (in Futterer's Durch Asien, iii, 1911, Land u. Süsswasserschnecken, p. 71, f. i, loess of Thung-fan yi and other places in northwestern China), is identical with *P. h. grandis.* It is distinctly swollen, while *signata* is strictly cylindric; on the right margin of the peristome there is a strong tooth-like thickening which is lacking or scarcely indicated in *P. signata;* there are besides differences in the teeth. He does not doubt that *signata* is to be deleted from the Chinese fauna, and that if intermediate forms are perhaps found in central Asia we can apparently separate the *signata-interrupta-heudeana* series only subspecifically.

Andreae's figures show no palatal plicæ. They are reproduced in pl. 22, figs. 8, 9.

(Indian species)

There is at present no satisfactory evidence that Pupilla lives anywhere in the Oriental Region. I have seen *P. annandalei* only; my knowledge of the other Indian species is secondhand. *P. eurina* appears to be a true Pupilla, but the river-drift specimens probably floated down from places well within the limits of the Palæarctic fauna; the inclusion of these two species in the Indian fauna is an accident of political boundaries. Nobody in this generation seems to have seen *scriola* or *diopsis;* they are probably not Pupillæ, but without seeing them, no opinion of value can be formed.

26. Pupilla annandalei n. sp. Pl. 22, figs. 10, 11, 12.

The shell is rimate, cylindric, with short, convexly conic summit and obtuse apex, the last 3 whorls about equal in diameter but regularly increasing in height. First 1½ whorls having a close, minute but very distinct thimble-like pitting; following whorls with fine but strong, nearly straight, very oblique striation, the striæ nearly as wide as their intervals. The whorls are rather strongly convex, the back of the last flattened and tapering downwards, deeply furrowed over the lower-palatal fold, a little swollen and then abruptly con-

tracted behind the lip; very little and slowly ascending in front. The aperture is small, rounded, subvertical, obstructed by four teeth: a nodular angular, continuous with a strong callous ridge running to the columella, some distance within the parietal margin; a stout, curved, entering parietal lamella, deeply placed; a very strong, blunt, axially lengthened columellar lamella, situated rather high, and a stout lower-palatal fold, deeply placed. The peristome is white, reflected, strongly thickened within except at the upper curve of the outer lip, where it becomes thin; it is continuous in a raised ledge across the parietal wall. Length 2.85, diam. above aperture 1.45, length of aperture 9.5 mm.; 6 whorls.

Upper Burma: Ava? (coll. Indian Museum, Calcutta, from W. Theobald).

Pupa (*Vertigo*) sp., G. NEVILL, Handlist of Mollusca in the Indian Museum, i, 1878, p. 197, no. 97.

Nevill doubted the locality Ava. It is probably not a shell of the Oriental fauna; more likely Theobald got it in Nepal, as it belongs to the central Asian group comprising *P. interrupta*, *P. heudeana*, *P. diecki* etc., found from northern China to Persia and southern Russia.

The type is decolored, whitish, perhaps a river-drift shell. Besides the striation, which is stronger than in any of its known allies, it is distinguished by the continuous peristome, by the transverse parietal callus, terminating in a rounded angular tubercle, widely separated from the strong parietal lamella, and by the single strong palatal fold, externally signalized by deep furrow.

Named for Dr. N. Annandale, who is doing admirable work on the freshwater mollusks of India.

27. PUPILLA EURINA (Benson). Pl. 22, fig. 20.

"Shell perforate, ovate-cylindric, rather solid, somewhat obliquely striatulate, rufous-chestnut, a little shining. Spire ovate-cylindric, the apex obtuse, suture impressed, submarginate. Whorls 7 to 7½, convex, the last ascending in front. Aperture semiovate, suboblique, toothless; peristome a little expanded, whitish, the right margin outwardly thickened posteriorly. Length 2.5, diam. 1 mm." (*Benson*).

India: Tribeni Ghat, Nepal (Theobald); Skardo, Kashmir (Godwin-Austen).

Pupa curina Bens., Ann. Mag. N. H. (3), xiii, 1864, p. 139. —Pfr., Monogr., vi, 1868, p. 300. — Hanley & Theobald, Conch. Ind., 1875, pl. 101, f. 7. — Godwin-Austen, Proc. Malac. Soc. London, iii, p. 260.—*Pupilla curina* Bens., Gude, Fauna Brit. India, ii, p. 283.

"Eight specimens from the Benson collection in Cambridge sent to me for inspection by Dr. L. Doncaster agree with the figure of the species in Conch. Ind., but the columellar margin is more obliquely ascending than is shown in the figure. They vary in length between 3 and 3.5 mm. The shell somewhat resembles a large *P. seriola*" (*Gude*).

Godwin-Austen remarks that "the typical specimens were found in the exuviæ of the River Gogra at Tribeni Ghat. This river rises in the Tibetan plateau, and these shells may have been brought down thus from far back in the mountain range."

28. Pupilla(?) seriola (Benson). Pl. 22, fig. 19.

"Shell slightly perforate, ovate-oblong, subcylindric, obliquely striatulate, silky, yellowish corneous. Spire oblong, the apex somewhat obtuse; suture impressed. Whorls 5, the upper ones convex, the last a little convex, slightly ascending in front. Aperture subovate, angular above, having one median and rather deeply placed parietal tooth; margins of peristome joined by a thin callus, the right margin slightly, columellar above broadly dilated.

"Length 2½, diam. 1⅓ mm." (*Benson*).

India: Region of Orissa, Cuttack (Theobald, type loc.); Darjeeling, Terai and Nawade near Muddapur (Mainwaring).

Ennea seriola Blanford, Journ. Asiat. Soc. Bengal, xxx, 1861, p. 359, name only.—*Pupa seriola* Bens., Ann. Mag. N. H. (3), xii, 1863, p. 427.—Hanley & Theobald, Conch. Ind., p. 41, pl. 101, f. 8.—*Pupilla seriola* Bens., Gude, Fauna Brit. Ind., Moll. ii, p. 284; also as *Pupisoma seriola* on p. 38.

Systematic position uncertain. "Benson states that in one of the two types there is a rather distant tooth midway be-

tween the two lips, and that the pillar lip is broadly expanded at its commencement. The type having been smashed, and an imperfect photograph alone preserved, we cannot vouch for the correctness of our figure'' (*Hanley & Theobald*). This figure is copied, as no specimens are available.

29. Pupilla(?) diopsis (Benson). Pl. 22, fig. 18.

Shell perforate, oblong-ovate, obliquely striatulate, with a few remote, slightly elevated striæ, whitish under a corneous epidermis. Spire oblong, conoid towards the rather obtuse apex, the suture a little impressed. Five slightly convex whorls, the last slightly ascending. Aperture oblong-ovate, angular above, two-toothed: a narrow, obliquely entering, median parietal lamella and an oblique, deeply-placed columellar tooth above. Peristome thin, the right margin simply straight, columellar margin expanded. Length 2, diam. 1 mm. (*Benson*).

India: Nerbudda valley.

Pupa diopsis Benson, Ann. Mag. N. H. (3), xii, Dec., 1863, p. 427.—Pfr., Monogr., vi, 306.—Hanley & Theobald, Conch. Indica, p. 41, pl. 101, f. 10.—*Pupilla diopsis* Bens., Gude, Fauna of British India, ii, p. 284.

A single specimen in a worn state was sent by Mr. W. Theobald for examination (*Bens.*).

''We have figured the unique original, which does not well display the remote columellar tooth ascribed to it; the name, says Benson, was a misprint for diploos'' (*Hanley & Theobald*).

Gude, who followed Pfeiffer in placing this species in *Pupilla*, adds nothing to the original account. Whether the species is a *Pupisoma*, *Nesopupa* or some other genus can hardly be guessed from the description and figure. It does not seem to be a *Pupilla*.

IV. African Species (Cape Verde Islands, Abyssinia, South Africa and Réunion).

Series of P. fontana (Section *Primipupilla*).

These species resemble closely the Oligocene and Miocene

forms of central Europe (*P. quadrigranata*, etc.), and are doubtless descendants of, or of common ancestry with, that stock. In apical sculpture and teeth they resemble the *P. signata* series of central Asia and the Australian species, all being in about the same stage of tooth-evolution. Parietal, columellar and sometimes angular lamellæ are present, and two palatal folds, or the upper palatal may be lost.

A stock of very similar but variable Pupillæ appears to have overrun Africa, from Abyssinia and the Cape Verdes to the Cape; but it has not been recorded from any part of the fully tropical area, and the three herds may prove to be quite isolated at present.

30. Pupilla fontana gorgonica (Dohrn). Pl. 23, figs. 11, 12.

Shell rimate, cylindric-oblong, somewhat shining, striatulate, brownish or yellowish corneous. Spire tapering above, obtuse. Whorls 6, a little convex, the last compressed basally, ascending in front, transversely pitted at base behind the aperture. Aperture subvertical, ovate, narrowed by four deeply placed folds: a compressed parietal, a transverse columellar, two palatals, that nearer the base forming an external pit, the upper one shorter. Peristome flesh-colored, expanded, the right margin nearly simple, sinuous. Length 3, diam. 1½, diam. aperture ¾ mm. (*Dohrn*).

Cape Verde Islands: S. Nicolao, type loc.; S. Antao, S. Vicente, Brava, Fogo, S. Jago for var. *minor;* S. Antao and S. Vicente for var. *brevior*.

Pupa gorgonica Dohrn, Malak. Bl., xvi, 1869, p. 12, with varieties 2, minor and 3, brevior.—Pfr., Monogr., viii, 1877, p. 397.—Morelet, Journ. de Conch., xiii, 1873, p. 242.—Wollaston, Testacea Atlantica, 1878, p. 516, with var. *a, subalutacea*.

Close behind the lip there is a narrow but rather strong crest followed by a narrow constriction, and preceded by an external furrow over the lower-palatal fold, as noted by Dohrn. The peristome is well thickened within, the callus excised at the sinulus. The parietal lamella is rather long, entering perhaps a third of a whorl. Lower-palatal fold

longer than the upper, as usual. The apical whorl is shallowly pitted, or in places appears weakly, irregularly granulose by running together of the pits. Striation of the later whorls is weak and sparse.

Length 3.1, diam. ab. apert. 1.65 mm.; 6 whorls.

Length 2.9, diam. ab. apert. 1.6 mm.; 5½ whorls.

Dohrn evidently did not intend the terms *brevior* and *minor* as names; he merely numbered the varieties. His typical form is the larger one, about 3 mm. long, drawn in the figure. Wollaston's var. *subalutacea* is synonymous with this form.

Dohrn's "Var. 2 minor: long. 2⅓, diam. vix 1¼ mill." is a small race. His "Var. 3 brevior, anfr. 5, convexioribus: long. 2⅓, diam. 1½ mill." is as Wollaston has noted, merely the short form of the typical more elongate race; they "cannot be treated apart, but pass into each other by imperceptible gradations."

P. f. gorgonica is probably not really separable from the continental *P. fontana*, and except for its geographic isolation would scarcely be considered a distinct race. The figured specimens are from Dohrn.

30*a*. Pupilla fontana (Krauss). Pl. 16, figs. 1-23 (17-19 typical).

"Shell small, perforate, ovate-cylindric, obtuse, brownish, pellucid, very finely striolate, silky. Whorls 7, convex. Aperture subangular-rounded, yellow; peristome acute, subreflected, the margins joined by a thin callus; parietal wall having one fold; three teeth, one on the columella, two in the depth of the right margin, the upper one [error: should be lower one] forming an external scar. Length 1.4, diam. 0.7 lines [about 3:1.5 mm.].

"The striation is extremely delicate and gives the surface a slightly silky luster. This species is extremely like the European *P. triplicata* Studer, and differs only by the two teeth in the depth of the right margin, the upper of which forms a little pit outside" (*Krauss*).

South Africa, Transvaal: Source of Mooi River (Wahl-

berg); Pretoria District (*custodita, kerœa, omicronaria,* &c., very plentiful); Johannesburg (McBean, Johnson); Potchefstroom, Heidelberg (Miss Livingston); Buiskop (Connolly). Natal: Karkloof (McBean); Edendale; Tongaat (Burnup). Cape of Good Hope: Prieska (Lightfoot); Cradock (*endoplax*) (Farquhar); Port Elizabeth (*amphodon, charybdica, frustillum,* Crawford, Penther); East London (Miss Bowker); Victoria East: Pirie Forest (Godfrey). Griqualand West: Blaauwbosch Poort, Hay District (Day). Damaraland: Gobabis, sub-fossil (Hermann).

Abyssinia: Asmara, Mekerka on the banks of the Toquor and on the Habab Hts., Enjelal, 7200-7995 ft., type and var. *globulosa* together (Jickeli). Senafé, Adigrat, Agula and Meshek, common at Tigré (Blanford).

Pupa fontana Krauss, Die Südafrikanischen Mollusken, 1848, p. 80, pl. 5, f. 6.—Kuester, Conchyl. Cab., p. 122, pl. 16, f. 9-12.—Pfr., Monogr., ii, p. 355.—Blanford, Obs. Geol. and Zool. Abyssinia, 1870, p. 477.—Jickeli, Molluskenfauna N.-O. Afrika's, 1874, p. 120, pl. 5, f. 11, and var. *globulosa,* p. 121, pl. 5, f. 11′.—Melvill & Ponsonby, Ann. Mag. N. H., i, 1908, p. 74 (synonymy).—Burnup, A. M. N. H., vii, 1911, p. 404.—*Jaminia fontana* (Krauss), Connolly, Reference List, Ann. S. Afr. Mus., xi, pt. 3, Oct., 1912, p. 180.—*Pupilla raffrayi* Bourguignat, Hist. Malacologique de l'Abyssinie, in Ann. Sci. Nat., xv, 1883, pp. 71, 115.—*Pupilla globulosa* Bgt., same vol., pp. 72, 116.—*Pupa charybdica* Melvill & Ponsonby, Ann. Mag. N. H. (6), xiv, August, 1894, p. 94, pl. 1, f. 13.—*Pupa custodita* M. & P., same vol., p. 93, pl. 1, f. 9.—*Pupa frustillus* M. & P., same vol., p. 94, pl. 1, f. 14.—*Pupa kerœa* M. & P., same vol., p. 94, pl. 1, f. 12 (*kerœa* Connolly).—*Pupa omicronaria* M. & P., same vol., p. 93, pl. 1, f. 11.—*Pupa amphodon* M. & P., A. M. N. H. (6), xviii, Oct., 1896, p. 317, pl. 16, f. 6, 7.—*Pupa endoplax* M. & P., A. M. N. H. (7), viii, Oct., 1901, p. 319, pl. 2, f. 10.

P. fontana is a small, compact, usually 4-toothed species. It sometimes has an angular lamella in form of a callous pad or low oblong tubercle (as in pl. 16, figs. 6, 20, 23), but more often this is not perceptible. The last whorl is flattened ex-

ternally and usually more or less furrowed over the lower palatal fold. There is a crest behind the lip, either rather strong and rounded, followed by a moderately wide, shallow contraction, or narrower and crowded close to the lip, or sometimes hardly noticeable. The crest and palatal impression vary a good deal in the same lot.

In Abyssinia what has been considered the typical form of *fontana* was found by Jickeli and others (pl. 16, fig. 15, after Jickeli). Jickeli gives the measurements:

Length 3.25, diam. 1.75, aperture 1 mm.

Length 2.4 to 2.5, diam. 1.5 mm.

Length 2.25, diam. 1.37 mm.

Length 2, diam. 1.5 mm.

The last two measurements pertain to the mutation *globulosa* Jickeli (pl. 16, fig. 16), a short, stout form of 5½ whorls, found with the typical form, analogous to the short forms of South Africa, also in those occurring in most lots of Pupilla everywhere.

Bourguignat, who had specimens collected by Raffray on the col of Abuna-Yusef, 4024 meters, separated the Abyssinian form as *Pupilla raffrayi*. He calls attention to the deep, more open umbilical perforation, the more pronounced projection at the upper third of the lip-callus, the anteperistomial crest, etc., differences which lose their value when a large series of the South African species is at hand. The short Abyssinian form, *globulosa* Jick., was taken by Raffray at Mont Zebul, 1994 meters, and on the high plateaus of Hamacen and Anderta. Bourguignat considered it a distinct species.

Both *raffrayi* and *globulosa* have been reported from Monte Cherseber, Eritrea, coll. by Gen. di Boccard (Pollonera, Boll. Mus. Zool. Anat. Comp. Torino, xiii, no. 313, p. 5).

In a species which has been named so many times by the same authors, it has seemed well to discuss and illustrate the local forms somewhat more fully than would otherwise be thought necessary.

It will be seen that most lots vary a good deal in length, much less in diameter. Whether the short forms are mutations or merely individual differences due to food or other

conditions is unknown; but this is a variation common in *Pupilla* and many other cylindric land shells. A more significant variation is the lengthening of the lower palatal and to a smaller degree of the other teeth in some colonies. Whether this has racial value must be left to South African students to decide.

The type locality is not far from Potchefstroom, in the southern Transvaal. The types were rather long shells (pl. 16, figs. 17-19, after Krauss) with both palatal folds tubercular, according to the figures.

Küster's figures, from a specimen in Pfeiffer's collection, doubtless one of the original lot, represent a shorter form similar to the following.

Many specimens from the southern Transvaal (Potchefstroom, Heidelberg, Johannesburg) before me from Mr. Burnup's collection are similar but slightly shorter with one whorl less, selected shells from Heidelburg, pl. 16, figs. 1, 2, measuring:

Length 2.72, diam. 1.45, aperture 0.9 mm.; 6 whorls.

Length 2.72, diam. 1.5, aperture 0.95 mm.; 6 whorls.

Length 2.3, diam. 1.45, aperture 0.85 mm.; 5½ whorls.

From Pienaar's Poort (Connolly) there are two forms: a stouter shell, strong-toothed and thick-lipped, with the lower palatal long, as in "*endoplax*" and the Port Elizabeth shells; length 2.6, diam. 1.5 mm.; 6 whorls (pl. 16, figs. 8, 20); also more delicate shells with smaller but otherwise similar teeth; length 2.67, diam. 1.4 mm.; 6¼ whorls.

In the Orange Free State (Burnup coll.) at Kroonstad (pl. 16, fig. 3), Bloemfontein (fig. 4) and Rustfontein the prevalent form is short, but slightly more solid than those farther north, with the upper palatal fold often weak or wanting; but there are also longer shells. The lower palatal fold is often somewhat long.

Length 3.1, diam. 1.72, aperture 1 mm.; 6 whorls. Bloemfontein.

Length 2.3, diam. 1.4, aperture 0.75 mm.; 5½ whorls. Bloemfontein.

Length 2.57, diam. 1.46, aperture 0.9 mm.; 5⅔ whorls. Kroonstad.

In Natal (Burnup coll.), at Edendale Falls and Tongaat Beach the shells resemble those from the Transvaal.

In the Cape Province, Farquhar and others have collected abundantly about Cradock. The race *endoplax* M. & P. is a rather long shell with strong teeth, the lower palatal fold especially long, the upper shorter though often somewhat lengthened (pl. 16, fig. 23, type fig. of *endoplax,* and fig. 22). With these there are also shorter shells with both palatal folds tubercular (fig. 21), and a few specimens of more or less intermediate character. The same forms are found at Grahamstown, but here the palatal folds of *endoplax* are less strongly developed.

At Port Elizabeth there are long shells with the lower palatal fold long (pl. 16, figs. 6, 7), called *charybdica* M. & P., practically identical with *endoplax;* also shorter shells with the same armature, and others with the palatals tubercular or but slightly elongate. The mutation *elizabethensis* M. & P. (pl. 16, fig. 5) is an albino form, occurring in abundance, of the medium size. It has the beautiful white or greenish-white tint everywhere common to albino mutations of Pupæ. In one of the lots it was sent with brown shells; whether they were associated in life I do not know. All of these varying sizes and colors of the Port Elizabeth race have strong teeth.

Length 3.75, diam. 1.75 mm.; 7 whorls.

Length 2.6, diam. 1.55 mm.; 5½ whorls.

Length 2.5, diam. 1.65 mm.; 5½ whorls.

Length 3.3, diam. 1.7 mm.; 6¾ whorls; albino.

Length 2.9, diam. 1.57 mm.; 6½ whorls; albino.

Though the Port Elizabeth shells vary widely in shape, the extremes are well connected, and appear to me certainly all of one race, characterized by the more or less elongate lower palatal fold.

The numerous forms described by Melvill and Ponsonby came from the Cape Colony around Port Elizabeth (*amphidon, frustillum, elizabethensis, charibdica*), and from Cradock, about 130 miles north (*endoplax*), and from the Transvaal around Pretoria (*custodita, kerœa, omicronaria*). These authors worked under the handicap of an incompetent artist;

but false as the figures are, they seem better than the descriptions. Both are reproduced below, the figures by photography. In most cases the teeth were not all seen, or were described and figured incorrectly.

All of the following forms have been considered synonyms of *P. fontana* by Melvill and Ponsonby in their last paper (1908) on the subject. Burnup (1911) writes: "Of the eight forms consigned to the synonymy, I have seen well-authenticated specimens of four only, viz., *amphodon, elizabethensis, endoplax,* and *frustillum;* and I agree with the authors that these names cannot stand. Of the remaining four, viz., *charybdica, custodita, keræa,* and *omicronaria,* having seen no representatives, I can offer no opinion; but I am prepared to accept their views."

Pupa custodita. Pl. 16, fig. 14. Shell umbilicate, obese, cask-shaped, minute, thin, brown, whorls 6, ventricose, very closely, longitudinally, delicately striate; aperture ovate; peristome white, reflected, provided with 5 internal teeth, one parietal, one columellar, three labial. Length 3, width 1.5 mm. Pretoria.

Much the same in ventricose tumidity of whorl and superficial appearance to the *P. psichion* just described, but entirely differing in the internal armature of the mouth, which, apparently simple externally, is really guarded within by no less than five teeth, three of these being labial, one sutural, and one columellar. It is a highly interesting species, and seems, though of the *fontana* group, to bear no very direct resemblance to hitherto described species (*M. & P.*).

Pupa omicronaria. Pl. 16, fig. 9. Shell minute, cylindric, straight, brown; whorls 7 (in one specimen 8), ventricose, very finely longitudinally striate, the striæ oblique; aperture ovate-rotund; peristome pale, simple. Length of largest specimen 3, width 1.5 mm. Pretoria.

This shell comes next to our *P. quantula,* and may perhaps eventually turn out to be a variety of that species. The mouth, however, is rounder and the form a little less cylindrical (*M. & P.*).

Pupa keræa. Pl. 16, fig. 10. Shell very minute, brownish, cylindric; whorls 6, straight, longitudinally delicately striate; aperture ovate; peristome pale, reflected, provided with one sutural tooth within. Length 2.15, width 1 mm. Pretoria.

A small, insignificant shell, with one internal sutural or parietal tooth. Two specimens (*M. & P.*).

Pupa charybdica. Pl. 16, fig. 11. Shell compact, rather thick, cylindriform, brown, apex obtuse; whorls 7, straight, longitudinally obscurely and obliquely delicately striate; aperture rounded; peristome thickened, pale, reflected, provided within with three mamillar teeth, one parietal, another columellar, the third basal. Length 3, diam. 1.15 mm. Coerney, near Port Elizabeth.

A cylindrical dark brown shell, not shining, stouter in substance than most of its congeners; whorls seven, straight, longitudinally, obscurely and obliquely finely striate; aperture round; peristome incrassate, reflexed, furnished with three internal teeth—basal, columellar, and sutural. Three specimens (*M. & P.*).

Pupa frustillum. Pl. 16, fig. 13. Shell glossy, cylindric, bright brown; whorls 7, straight, obliquely very finely striate; aperture ovate; peristome pale brown, provided within with three teeth: one parietal, another basal, the third columellar. Length 3.5, width 1.25 mm. Port Elizabeth.

Near *P. fontana* Krauss, but more cylindrical than that species, and differing besides in the tooth-processes (*M. & P.*).

Pupa elizabethensis. Pl. 16, fig. 5, topotype. Shell minute, openly rimate, glossy, shining white, shortly cylindric; whorls 7, lightly subventricose, most minutely striatulate under a lens; aperture rounded, provided with two entering folds, one parietal, the other columellar, deeply entering; peristome a little reflected. Length 3, width 1.2 mm. Port Elizabeth (Miss Glanville) (*M. & P.*).

Pupa amphodon. Pl. 16, fig. 12. A small cylindrical species of the *fontana* group. In many ways it approaches *P. frustillum* M. & P., but differs entirely in the labial tooth-processes. It is subrimate, with seven whorls, two of them being apical, the apex itself extremely obtuse; whorls slightly ventricose and indistinctly longitudinally striate; mouth lunar, peristome round, furnished with five processes, which well-nigh close the orifice. The parietal tooth is the most conspicuous of these and is straight and produced, the labial is broadly triangular, the two basal are respectively doubly mamillar and broadly triangular, and the remaining columellar tooth is smaller, rounded, and mamillar. The peristome is incrassate, reflexed, and broader towards the columellar region (*M. & P.*).

Pupa endoplax. Pl. 16, fig. 23. Shell obese, cylindriform, brown, thin; whorls 6-7, a little impressed at the suture, somewhat swollen, longitudinally obliquely striate, the last whorl rounded towards the base; aperture lunate-ovate; peristome thickened, scarcely continuous, 4-folded: an acuminate sutural fold, a mamillate columellar, and two slightly curved internal folds, not reaching to the peristome. Length 3, width 1.5 mm. Cradock, at roots of bushes (Farquhar).

A curious and distinct form, with the peculiar internal plaits just in front of the orifice, but not reaching the peristome (*M. & P.*).

31. Pupilla pupula (Desh.). Pl. 17, figs. 12, 13, 17, 18.

It is perfectly cylindric, equally obtuse at the ends, of 7 whorls; the first ones are flat, the following are moderately convex and united by a simple, lightly impressed suture, increasing very slowly and hardly noticeable; the last whorl is very short, and barely a third of the entire length. Very obtuse at base, it is perforated in the center by a quite large umbilicus. The aperture is small, but slightly oblique, a little bent in on the right; it is oval, semilunar, and when examined under the lens a small white tooth which appears to run along the wall is found. Equally deep within there are found on the left, in front, two little teeth a little less elevated than the first (and which the draughtsman did not represent, as they are very deeply placed; *cf.* fig. 17). The margin is reflected, and is thickened within by a little russet-white callus. The whole shell is dark brownish-corneous, thin and semitransparent. Its surface appears smooth, but oblique growth-striæ may be noticed under a sufficient magnification, especially near the aperture. Length 3, diam. 1½ mm. (*Desh.*).

Island of Réunion (L. Maillard); abundant on large boulders overgrown with creepers, near Salazie (Nevill).

Pupa pupula Deshayes, Cat. Moll. de l'île de la Réunion (Bourbon), p. 92, pl. 11 (38), f. 2-4, 1863; in L. Maillard's Notes sur 'ile de la Réunion. — Pfr., Monogr., vi, 303.—*Vertigo? pupula* Dh., G. Nevill, Journ. Asiat. Soc. Beng. 39, 1870, pt. 2, p. 412.

Under the microscope the surface shows extremely fine, close, somewhat anastomosing striæ (in places apparently with

thin cuticular edges) and a minute granulation. The embryonic 1½ whorls have a microscopic reticulation like that of *P. heudeana,* being densely, shallowly pitted. The last whorl has a low, rounded crest of the brown color of the shell, followed by a light constriction; on its last half it is much flattened, tapering downwards, and having a deep furrow over the lower-palatal fold. The suture rises slowly to the aperture. The strong but immersed parietal lamella continues about a third of a whorl inward. On the columella there is a strong, white oblong tubercle, usually visible but sometimes so deeply immersed that it can be seen in an oblique view only. The lower-palatal fold is long and strong, the upper short, tubercular. The peristome is reflected, not much thickened within, of a pale brown tint; margins connected by a thin parietal callous film, which is rather coarsely granulose. There is no trace of an angular lamella or tubercle. There is a moderately long umbilical crevice but no true umbilicus.

Length 3, diam. above aperture 1.5 mm.; 6½ whorls.

Length 3.25, diam. above aperture 1.6 mm.; 7 whorls.

By the apical sculpture, teeth, and furrow over the lower-palatal fold, this species is related to the South African *P. fontana.* Indeed were it not for the somewhat longer parietal lamella and lower palatal fold, and the more coarsely granose parietal wall, it would hardly be separable from *P. fontana.* It is a case where locality is diagnostic, to a large degree.

A specimen collected by G. Nevill is illustrated, figs. 12, 13; another in the same lot is longer. In figs. 17, 18 Deshayes' imperfect figures are reproduced.

Series of P. tetrodus (Section *Afripupilla*).

Shell tapering upwards from the last whorl, the whorls increasing rapidly in height. Type *P. tetrodus.* The teeth are like those of the most fully toothed Pupillas of the section *Primipupilla,* but the shell is more like a *Gastrocopta* in shape and increase of the whorls. Systematic position somewhat uncertain.

32. Pupilla tetrodus (Boettger). Pl. 17, figs. 9, 10, 14-16.

Shell sinistral, obliquely rimate, ovate-conic, rather obtuse at the apex. Whorls 5½, glabrous, a little convex, the last much more ample than the preceding, nearly equal to all the preceding in height. Aperture large, strongly oblique, in general shape semioval, 4-plicate: one deeply entering parietal lamella, one dentiform columellar, and two distant dentiform palatals, the lower one much more prominent. Peristome a little expanded, margins joined by a thin callus (*Boettger*).

South Africa: Betchuanaland, fossil in clay bed at the mouth of the Gowke river, flowing into the Limpopo, 22° s. lat., 28° e. lon. (Adolf Hübner; type loc.). Cape of Good Hope at Cape Recif; Klein Setjes Bosch near Beaufort (type localities of *P. sinistrorsa*, Craven); Port Alfred (Penther); King Williamstown; Lovedale; Burns Hill (Godfrey); Port Elizabeth (Crawford, type loc. of *thaumasta*); Prieska (Gibbons); Grahamstown; Cradock; Jansonville; Somerset East (Farquhar); Coega (Miss Hickey). British Betchuanaland: Hartz River, Taungs (Miss Wilman). Transvaal: Pretoria (Connolly); Potchefstroom (Miss Livingston). Orange Free State: Bloemfontein (Godfrey); Kroonstad (Miss Hickey). Ovampoland: Disappointment Vlei (coll. Layard).

Pupa tetrodus Boettger, 11ter Bericht Offenbacher Vereins f. Naturkunde, 1870, p. 46, pl. 1, f. 1*a-c*.—Burnup, Ann. Mag. N. H. (8), vii, 1911, p. 410.—*Pupilla tetrodus* Bttg., Abhandl. Senck. Naturf. Ges., xxxii, 1910, p. 446. — *Jaminia tetrodus* (Boettg.) Connolly, Ann. S. Afr. Mus., xi, pt. 3, p. 184.—*Pupa (Vertigo) sinistrorsa* Craven, Proc. Zool. Soc. Lond., 1880, p. 618, pl. 57, f. 8.—Melvill and Ponsonby, Ann. Mag. Nat. Hist. (8), i, Jan., 1908, p. 83, pl. 2, f. 26.—*Vertigo sinistrorsa* Craven, M. & P., Proc. Malac. Soc. Lond., iii, 1898, p. 177. — *Vertigo thaumasta* Melv. & Pons., Ann. Mag. N. H. (6), viii, 1891, p. 239; ix, 1892, p. 94, pl. 6, f. 7.

A very distinct species by its tapering spire, absence of a crest, and high last whorl. The rather glossy surface is pale cinnamon-buff, slightly transparent. The apex has a weak, very minute granulation. The parietal lamella is high, rather

short and straight. There is sometimes a minute, tubercular angular lamella a short distance below the insertion of the outer lip. The parietal callus is very thin and transparent. The lower-palatal fold is large, the upper small or very small. Short and long examples measure:

Fig. 10. Length 3, diam. ab. apert. 1.45 mm.; 5¼ whorls. Cradock.

Fig. 9. Length 3.55, diam. ab. apert. 1.5 mm.; 5¾ whorls. Coega.

The original specimens of *P. tetrodus* were decidedly stouter in figure than the recent form (*sinistrorsa* = *thaumasta*) if we may judge by Boettger's figures, reproduced in pl. 17, figs. 14-16. Unfortunately he gave no measurements, but indicates on the plate that they are magnified 7 times; this would make *tetrodus* 3 mm. long, very nearly 2 wide. The figures show also an external impression of the last whorl over the palatal region deeper than the flattening to be seen in the recent form. The shape of the aperture also is somewhat different. It is not impossible that Boettger's figures are incorrect. He drew freehand, usually with great accuracy, though often rather diagrammatically. In his later work Boettger mentions specimens from Gobabis, Damaraland, measuring 3 x 1½ mm., agreeing in size, he says, with the originals.

Craven's *Pupa (Vertigo) sinistrorsa* is the ordinary living form. The original description follows.

Shell sinistral, subperforate, ovately conical, of a horny brown color, paler near the apex, rather glossy, faintly striated by the lines of growth; whorls 5½, very convex, gradually increasing, the last two equal in diameter; suture deep and well defined; aperture nearly circular, armed with four internal teeth, viz.: one large tooth situated on the paries near its centre, another smaller tooth on the columella far within the aperture, another at the base of the outer lip, and a very small one at its centre; labrum outwardly reflexed; extremities of peristome connected by a thin callosity. Length 3 to 3¾ mm., greatest diameter 2, diameter of aperture 1 (*Craven*).

V. Australian Species.

The Australian Pupillæ belong to the section *Primipupilla,* being related to the *signata* series of Asia. They have the same reticulate-pitted sculpture of the embryonic shell, and an angular lamella, in form of a nodule, is generally present.

Only two species are certainly known; *P. scotti* Braz. was based upon an immature shell only about 1.5 mm. long according to Brazier, and thus much smaller than any known Pupilla. It is left here for want of any better place.

a. Shell 3 to over 4 mm. long, 1.5 to 1.8 mm. in diameter: lip reflected and thickened.

b. Sinistral; no upper-palatal fold. Coastal, from Sydney and South Australia to West Australia. *P. australis,* no. 33.

*b*¹. Dextral; upper and lower palatals present. Central Australia. *P. ficulnea,* no. 34.

*a*¹. Shell about 1.5 mm. long; dextral, N.-E. Australia. *P. scotti,* no. 35.

33. Pupilla australis (Angas). Pl. 23, figs. 13 to 19.

Shell sinistral, obtuse at the apex, rimate-umbilicate, pale brown. Whorls 7, convex, obliquely strongly striate. Aperture semiovate; peritreme thickened and broadly dilated, provided with a single parietal and a single columellar fold. Length 2, width ¾ line (*Angas*).

A cylindric, and for the genus a large species, with the aperture furnished with but two plicæ (*Angas*).

Australia: along the coast from Sydney and South Australia to the islands off western Australia. New South Wales: Nelson Bay (King, type loc. of *P. nelsoni*) and Sirius Cove (Hedley), both near Sydney. South Australia: Rapid Bay, in crevices of rocks (Angas, type loc. of *P. australis*); Port Lincoln (Masters, type loc. of *P. lincolnensis*); Edithburg (Hedley). Western Australia: Pigeon Island, near Wallaby I. (Dr. Richardson); E. Wallaby I., and Houtmans Abrolhos (J. J. Walker). Tasmania: Swansea, sand dunes (Johnston, type loc. of *P. tasmanica*).

Vertigo australis Ad. & Ang., Angas, Proc. Zool. Soc. Lond., 1863, p. 522.—*Pupa australis* Cox, Mon. Austr. Land Sh., p. 79.—Tate, Rep. Horn Exped. Central Australia, ii, Mollusca, p. 205. — *Pupa nelsoni* Cox, Catal Australian Land Shells, 1864, p. 29; Mon. Austr. Land Shells, 1868, p. 79, pl. 14, f. 19, 19a.—*Pupa lincolnensis* Cox, Proc. Zool. Soc. London, 1867, p. 39. — Sowerby, Conch. Icon., *Pupa*, pl. 11, f. 104. — E. A. Smith, Proc. Malac. Soc. London, i, p. 96 (dist. in W. Australia). — *Pupa lincolniensis* Cox, Mon. Austr. Land Shells, 1868, p. 80, pl. 14, f. 16.—*Vertigo lincolnensis* Cox, Petterd & Hedley, Rec. Australian Mus., vii, p. 283.—*Pupa tasmanica* Johnston, Proc. Roy. Soc. Tasmania for 1882, p. 144, plate, as synonym of "*P. lincolnensis* Angas."

The cylindric shell is shortly rimate, from cinnamon-brown to cinnamon colored, the lighter specimens sometimes showing the columellar axis faintly through. Typically it is rather coarsely striate, but this is individually variable in the lots seen. The embryonic whorls are irregularly, densely but shallowly pitted, as in the *P. signata* series. The last whorl is somewhat compressed towards the narrow, rounded base, and generally very superficially furrowed over the lower palatal fold. It is slightly swollen before the contraction preceding the lip. The aperture shows an angular nodule connected with the termination of the lip (sometimes nearly obsolete); a deeply placed parietal lamella, not very long; a small, deeply immersed columellar tubercle, and a short, deeply placed lower-palatal fold, almost basal in position (and sometimes wanting). Parietal callus thin. The peristome is rather narrowly reflected and is thickened within.

Length 4, diam. ab. apert. 1.8 mm.; 6½ whorls. Edithburg.

Length 3.8, diam. ab. apert. 1.75 mm.; 6½ whorls. Edithburg.

Length 3.45, diam. ab. apert. 1.72 mm.; 5¾ whorls. Edithburg.

Length 4.15, diam. ab. apert. 1.75 mm.; 6¾ whorls. Australia.

Length 3.1, diam. ab. apert. 1.6 mm.; 5½ whorls. Australia.

Figures 13, 14 are from Edithburg specimens; this place is opposite the type locality, Rapid Bay, on St. Vincents Gulf. Larger and smaller shells, but without exact locality, are also measured above (figs. 17, 19).

The Sydney form, *nelsoni*, is drawn in figs. 15, 16, "Sirius Cove, among dead leaves raked out of a rock crevice. This has rarely been gathered, and never out of sight of salt water," according to Hedley (*in litteris*). It is a little smoother than the South Australian shells, and the teeth are stronger. Length 3.8, diam. above aperture 1.8 mm.; 6½ whorls. The specimens figured were compared by Mr. Hedley with a cotype of *nelsoni*.

P. australis appears to be spread along the coast from Sydney to Western Australia, yet there are wide gaps in the southeast and southwest between the recorded localities. Professor Tate notes that it "is essentially confined to the coast, and I have traced it from St. Vincent Gulf along the coastal sand hills into West Australia."

Descriptions of the several synonyms follow.

Pupa nelsoni.—Shell sinistral, perforate, elliptically cylindrical, thin, smooth, microscopically striated, horny reddish-yellow, slightly shining; spire slowly narrowing, obtusely rounded: whorls 5 to 6, slightly convex, last about ⅓ the length of the shell; aperture large, rounded, truncate above, with a conspicuous lamelliform tooth on the wall of the aperture, and another, or tubercular callosity, sometimes larger, but obsolete in young specimens at the columellar junction; peristome and teeth white, former expanded, especially at the columella, and not obstructing the minute umbilical opening at the bottom of a deep fissure. Length 0.15, breadth 0.07, aperture 0.05 long, of an inch. Nelson Bay, near Sydney, N. S. W., King (*Cox*).

Pupa lincolnensis (*lincolniensis*). — Shell sinistral, rimate, elliptically-oblong, very finely obliquely striated, whitish or rufous horny; spire obtuse; whorls 4 to 6, rather convex, last by no means equalling the rest; aperture almost vertical, lunately-circular; peristome thickened, expanded, white, margins distant, columellar margin straight, sinistral margin above obtusely angled; body whorl centrically armed with a prominent, obtuse, white tooth. Length 0.13, diameter 0.08 of an inch. Port Lincoln, South Australia (*Cox*).

Pupa tasmanica (pl. 23, fig. 18). — Shell minute, sinistral, thin, of a uniform light fawn colour, sub-pellucid, oblong, cylindrical, obliquely finely lirate; suture somewhat impressed; spire scarcely contracted towards apex, which is suddenly obtusely rounded; whorls 6, slightly convex, aperture somewhat squarely ovate, subvertical, with a moderately prominent tooth; peristome simple, margins distant, united by a callous lamina; anterior and columellar margins slightly reflexed. Length 3 min., diam. 1.75 min. Habitat, sand dunes, Swansea, abundant (*Johnston*).

34. PUPILLA FICULNEA (Tate). Pl. 23, figs. 20, 21.

Shell dextral, shortly cylindric-elliptical; apex obtuse, pale brown, shining. Whorls six, flatly convex, separated by a channellel suture, obliquely striated. Aperture roundly-oblong, rounded in front and somewhat obliquely truncated behind, furnished with two folds, one parietal large, blunt, situated centrally and far within, the other, nearly as large and similar, is situated far within on the columella; a small denticle is sometimes developed at the insertion of the outer lip; peristome white, flatly expanded, the columellar expansion not concealing the deep, narrow umbilical fissure. Length 3.5, width 1.75 *vix* (*Tate*).

Central Australia: Palm Creek, off Glen of Palms, in Krichauff Range (Horn Exped.).

Pupa ficulnea TATE, Trans. Roy. Soc. S. Australia, xviii, 1894, p. 191; Rep. Horn Expedition, ii, 1896, Mollusca, p. 205, pl. 19, f. 18*a*, 18*b*.—PILSBRY, Proc. A. N. S. Phila., 1900, pp. 426, 428, fig. 2.

P. ficulnea of the interior is very similar to the coastal *P. australis* in shape, sculpture, color, suture and peristome. It differs by the dextral coil, the larger teeth, presence of an upper-palatal fold, and greater external compression and impression over the lower-palatal fold. It is not so strongly sculptured as the rougher examples of *australis*, the striation being minute and weak.

The angular nodule is strongly developed in old shells, but often hardly perceptible in others which have formed the lip. The columellar lamella is strong and blunt. There are two palatal folds, not mentioned by Tate, but present in 16 topo-

types received from him, the lower one strong and elongate, externally marked by a furrow, the upper one small, tubercular. The last whorl has behind the lip a swelling followed by a contraction, both individually variable in degree of development.

Length 3.4, diam. 1.6 mm.; 6 whorls.

Length 3, diam. 1.5 mm.; 5½ whorls.

35. Pupilla(?) scotti (Brazier). Pl. 23, fig. 22.

"Shell dextral, fissured, cylindrical, thin; transparent, pale brown; whorls 5½, roundly convex, last small, obliquely and transversely faintly striated; apex roundly obtuse; aperture small, ovate-denticulated within with 4 prominent white teeth, one placed on the body-whorl, elongated and rounded; a second on the columella, large and acute; two placed inside the outer lip, the lower one long and prominent, the upper moderate and rounded; peristome whitish, thickened and expanded; margins continuous, with a thin coating of the callus over the perforation. Length ¾, breadth ½ lines" (*Brazier*).

Australia: Fitzroy Island, Queensland; only one specimen obtained, at the watering place, under a bit of wood (Brazier).

Pupa (Vertigo) scotti Brazier, Proc. Zool. Soc. London, 1874, p. 669, pl. 83, fig. 24-26.

It does not appear likely that a shell so small as this is a *Pupilla*. It may prove to be a *Costigo* (Vol. XXV, p. 366), if that somewhat nebulous group be retained. Hedley writes: "In the Australian Museum is one specimen labelled in Brazier's hand '*Pupa scotti*, Braz. Fitzroy Isd. N. E. A.' As he particularly stated that but one was found (and no others have since been obtained), this is clearly his type. I am much puzzled to find that this type disagrees with the figure, P. Z. S., 1874, pl. 83, figs. 24, 25, 26. Brazier, who is now 74, has no recollection of the matter, except that the type was unique. I enclose a camera lucida sketch drawn by myself of this type of *scotti*. My opinion is that it is an immature specimen and that it represents a Pupilla distinct from other Australian species. Possibly Brazier, recognizing its immaturity, instructed the artist to 'develop' the labial armature."

Hedley's pencil sketch of the type is reproduced on my plate.

VI. Tertiary Fossil Species.

36. Pupilla quadrigranata (Al. Brn.). *Pupa quadrigranata* Al. Braun, Verh. Naturf. Vers. zu Mainz, 1842, p. 119.—*Pupilla quadrigranata* (Al. Br.) Boettger, Jahrb. Nassau. Ver. Naturkunde, 42, 1889, p. 251, pl. 6, f. 3, 4.—*Pupa selecta* Thomae, Jahrb. Nassau. Ver. Nat., 2, p. 150, with mut. *suprema* Bttg., p. 253.—*Pupilla selecta suprema* Bttg., Wenz, Jahrb. Nassau. Ver. Nat., 69, 1916, p. 63.

Upper Oligocene to Lower Miocene. Germany. *P. selecta* is now generally considered distinct.

37. Pupilla eumeces (Bttg.). *Pupa quadrigranata* var. *eumeces* Boettger, Ber. Senckenb. Nat. Ges., 1884, p. 266.—*Pupilla eumeces* Bttg., Jahrb. Nassau. Ver. Nat., 42, 1889, p. 255, pl. 6, f. 5. Lower Miocene of Schleusenkammer bei Niederrad. Considered a variety of *P. iratiana* by Gottschick & Wenz, 1919.

Pupilla eumeces maxima Boettger. Nachrbl. D. Malak. Ges., 40, 1908, p. 150.

38. Pupilla impressa (Sandb.). *Pupa impressa* Sandberger, Mainzer Becken, 18.., p. 392, pl. 35, f. 16.—*Pupilla impressa* (Sbgr.) Boettger, Jahrb. Nassau. Ver. Nat., vol. 42, 1889, p. 256; vol. 64, 1911, p. 61. Lower Miocene, Germany.

39. Pupilla cupella Boettger. P. retusa Bttg. (not Al. Braun), Ber. Senck. Ges., 1884, p. 265, pl. 4, f. 6.—*Pupilla cupella* Bttg., Jahrb. Nassau. Ver. Nat., 42, 1889, p. 259. Lower Miocene, Schleusenkammer, bei Niederrad. Mut. *lauberi* Bttg., t. c., p. 260, pl. 6, f. 6. Hydrobiaschichten, Mosbach-Biebrich.

40. Pupilla blainvilleana (Dupuy). *Pupa b.*, Dup., Journ. de Conch., i, 1850, p. 311, pl. 15, f. 8.—*Vertigo blainvillei* Dupuy, G. F. Dollfus, Bull. Soc. Geol. Fr. (4), xv, 1915, p. 359. Middle Miocene, Sansan (Gers). A sinistral *Primipupilla*.

41. Pupilla staszicii (Lomnicki). *Pupa staszicii* Lom., Verh. K. K. Geol. Reichsanst., 1886, p. 423. Miocene, Barysz, Galizia.

42. Pupilla m.lommickii (Friedb.). *Pupa (Pupilla) m. lommickii* Friedberg, Sitzungsber. Math.-Nat. Kl. K. Akad. Wiss., Wien, vol. 114, 1905, p. 312, pl. 1, f. 15; text fig. 2. Miocene, Sobow, Poland.

43. Pupilla iratiana (Dupuy). *Pupa iratiana* Dupuy, Journ. de Conch., i, 1850, p. 310, pl. 15, f. 7.—Bourguignat, Malac. colline de Sansan, 1881, p. 65, pl. 3, f. 82-85.—*Vertigo irati* Dollfuss, 1915.

Middle Miocene, Sansan (Gers); also Upper Miocene, Germany and Galizia.

Pupilla iratiana suevica Gottschick & Wenz. Nbl. D. M. Ges., 51, 1919, p. 5, pl. 1, f. 4, 5. Steinheim am Aalbuch.

44. Pupilla rahti (Al. Brn.). *Pupa rahti* Al. Braun, in Walchner's Geognosie, (2), p. 1136. — *Pupilla r.*, Boettger, Jahrb. Nassau. Ver. Nat., 42, 1889, p. 254. — Jooss, same Jahrb., 64, p. 63.

Upper Miocene, Hydrobiaschichten of Mosbach-Biebrich, etc.

45. Pupilla perlabiata Gottschick & Wenz., Nbl. D. M. Ges., 51, 1919, p. 7, pl. 1, f. 8, 9. Upper Miocene: Steinheim am Aalbuch. Belongs to section *Primipupilla.*

46. Pupilla steinheimensis (Miller). *Pupa (Pupilla) steinheimensis* Miller, Jahresh. Ver. Vaterl. Nat. Württemb., 56, 1900, p. 398, pl. 7, f. 15. *Pupilla steinheimensis* Gottschick & Wenz., Nbl. D. M. Ges., 51, 1919, p. 8, pl. 1, f. 10, 11. Upper Miocene: Steinheim am Aalbuch. A sinistral species of the section *Primipupilla.*

47. Pupilla submuscorum Gottschick & Wenz. Nbl. D. M. Ges., 51, 1919, p. 6, pl. 1, f. 6, 7. Upper Miocene, Steinheim am Aalbuch. Near *muscorum,* 3-toothed.

48. Pupilla(?) retusa (Al. Braun). *Pupa retusa* Al. Brn. Verhandl. d. d. Naturf. Vers. Mainz, 1842, p. 149.—? *Coryna*

retusa Jooss, Jahrb. Nassau. Ver. Nat., vol. 64, p. 911, pl. 62. I have not seen the description of this species, which may belong elsewhere.

49. Pupilla ectina (Bgt.). *Pupa ectina* Bourguignat, Paléont. Moll. Algerie, 1862, p. 76, pl. 4, f. 1-3. Pliocene? Oued Tademit, Algeria.

50. Pupilla michaudi Wenz, Senckenbergiana, i, July, 1919, p. 66; new name for *Pupa inornata* Michaud, Journ. de Conchyl., 1862, p. 75, pl. 4, f. 5. Hauterive (Drôme), Pliocene.

51. Pupilla palæa (Bgt.). *Pupa palæa* Bourguignat, Cat. Moll. terr. et fluv. des environs de Paris a l'epoque Quaternaire, 1869, p. 8, pl. 3, f. 16-18 (in La Seine.—I, Le Bassin Parisien aux âges antéhistoriques). Joinville-le-Pont, sablière Deligny. From the figure it appears to have a longer apical cone and stronger striæ than *P. muscorum*, but it may perhaps be equivalent to the mut. *masclaryana*, having parietal and lower-palatal teeth. Probably Pleistocene.

Genus BOYSIA Pfeiffer.

Boysia Pfeiffer, Zeitsch. Malak., vi, 1849, p. 105; Mon. Helic. Viv., iii, 1853, p. 528; Conchyl. Cab., *Helix*, ii, 1853, p. 6.—Adams, Gen. Rec. Moll., ii, 1855, p. 167.—Nevill, J. A. S. Beng., 1881, p. 128. — Pfeiffer & Clessin, Nomencl. Helic. Viv., 1881, p. 343. — Gude, Fauna of British India, Moll., ii, 1914, p. 296.—*Hypostoma* Albers, Die Heliceen, 1850, p. 130 (not *Hypostoma* Rudolphi, 1809, Vermes; not *Hypostoma* auct., *Hypostomus* Lacepède, 1803; not *Hypostoma* Gray, 1841, Echinodermata).—*Hypotrema* von Martens, Die Heliceen, 1860, p. 304, as section of *Pupa*. —"*Hypoma* Albers" Pfr., Nomencl. Hel. Viv., 1878, p. 343.—"*Hypostrema* Albers" Pfr., *loc. cit.*

The shell is small, globose-conoid, thin, smooth, rimate, of 5 compactly coiled whorls, the last half-whorl ascending obliquely, in close contact. Aperture toothless, directed obliquely upward, rounded, with straight parietal margin; peristome slightly expanded, thickened within, the parietal border barely free from the preceding whorl.

Type: *Boysia boysii* (Pfr.). Found only in India.

The classification of Pupillidæ having no teeth is an exceedingly difficult problem. When the tentacles and radula of *Boysia* are examined it may be possible to form some definite opinion of its affinities. Temporarily it may be left next to *Pupisoma*.

The generic and specific nomenclature of the single species has been fully discussed by Gude in The Fauna of British India. *Boysia reussii* Stoliczka (Sitzungsber. d. k. k. Akad. Wissensch., vol. 38, 1867, p. 493, pl. 1, f. 17*a-c*), from the middle Cretaceous of Neualpe in the eastern Alps, has been referred by Sandberger (Vorwelt, p. 80) to the Cyclostomaceous genus *Strophostoma*. *Anostomella* of von Martens has some superficial resemblance, but appears referable to the *Diplommatinidæ*.

Various Laramie and Eocene species of Wyoming have been referred to Boysia or its vicinity by Prof. T. D. A. Cockerell, but were subsequently removed by him. *Boysia sinclairi* Ckll. and *B. phenacodorum* Ckll. being referred to the genus *Grangerella*.

1. Boysia boysii (Pfeiffer). Pl. 24, figs. 14, 15, 16, 17.

"Shell arcuately rimate, compressed-conic, thin, smooth, diaphanous, pale corneous. Spire obliquely conoidal, little obtuse. Whorls 5, convex, the last arcuately ascending to the upper edge of the antepenult whorl. Aperture subtriangular-rounded, toothless; peristome nearly simple, a little expanded, the margins joined by a shortly free lamina. Alt. 3, diam. 3.5 mm." (*Pfr.*).

India: Chittore, Rajputana and Azmere (Boys); Nerbudda valley (Nevill, Stoliczka); Mandata, on the Nerbudda (Theobald coll.); Bengal (Cuming coll.).

Tomogeres boysii (*Anostoma*) Benson, Pfeiffer, Symbolae ad Hist. Hel., iii, 1846, p. 82.—*Anostoma boysii* Benson, Pfr., Monogr. Hel. Viv., i, 1847, p. 2.—Benson, Ann. Mag. N. H. (2), ii, 1848, p. 164.—*Hypostoma boysii* Benson, Albers, Die Hel., 1850, p. 130.—*Pupa (Hypotrema) boysii* Bens., von Martens, Die Hel., 1860, p. 305.—*Boysia boysii* Bens., Kobelt, Ill.

Conchylien Buch, ii, 1878, p. 278, pl. 85, f. 10.—*Boysia boysi* (Pfr.) Gude, Fauna Brit. India, Moll., ii, 1914, p. 297.—*Boysia bensoni* Pfeiffer, Zeit. Malak., vi, 1849, p. 105; Conch. Cab. Helix, 1853, p. 6, pl. 101, figs. 25-28.—Adams, Gen. Rec. Moll., ii, 1855, pl. 167, pl. 76, fig. 2.—Pfeiffer, Malak. Blatt., ii, 1856, p. 172.—Hanley & Theobald, Conch. Ind., 1870, pl. 8, fig. 1.

In the type specimen of this species (pl. 24, fig. 14, copied from Kuester) the last whorl ascended a little farther than in that drawn in pl. 24, figs. 15-17, from the Nerbudda valley (Indian Museum). The latter is also smaller, alt. 2.65, diam. 3.2 mm.

The shell is perforate, very compactly coiled, regular in shape as far as the last half-whorl, where the whorl becomes straightened and ascends. The peristome is slightly thickened within and a little expanded. The nearly straight parietal margin stands free of the penult whorl, and barely detached from the last whorl. The plane of the peristome stands at an angle of about 40° with the axis of the shell. The surface is smooth, some very faint growth-lines being visible under the lens. There is also a microscopic granulation, such as most Pupæ show under sufficient magnification. The apex appears to have only an extremely minute and indistinct granulation.

APPENDIX

Vol. XXIV. Gastrocoptinæ.

Gastrocopta moreletiana (Grasset). Pl. 24, figs. 4, 5.

Shell deeply rimate, ovate, short, corneous-whitish, rather glossy, smooth. Spire convex, tapering to the apex. Whorls 6, a little convex, the last somewhat compressed basally. Aperture obrotund, narrowed by 3-4 palatal denticles and a somewhat bifid lamella on the parietal wall near the insertion of the lip. Peristome a little reflected, a little thickened, the margins joined by a callus. Length 4, diam. 2 mm. (*Grasset*).

Canary Islands: Teneriffe.

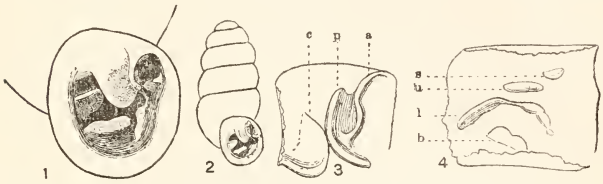
Pupa moreletiana A. Grasset, Journ. de Conch., v, 1856, p. 348, pl. 13, f. 7.

This species appears to be known by the original account only. Wollaston and Mabille do not mention it in their Canary Islands lists. It seems to be a *Gastrocopta*, but where it belongs in that genus is uncertain, and its locality will make further investigation highly interesting.

Gastrocopta colombiana Pils. Figs. 1-4.

The shell is thin, faintly brown tinted, subcylindric, but tapering very slowly from the last whorl, composed of 5½ strongly convex whorls, the last whorl somewhat flattened dorsally, with a slight impression over the inner part of the lower palatal fold. Faintly striate. The aperture is squarish-oval; peristome thin, well expanded and reflected, continuous across the parietal wall, but very shortly adnate there. The angulo-parietal lamella reversed *y*-shaped, the angular sinuous, emerging to the lip edge, parietal arcuate, higher, emerging much less. Columellar lamella strong, lunate, the inner half descending, outer horizontal. Within the outer lip there is a small, high, suprapalatal fold and a larger, more

immersed upper palatal. Lower palatal fold is very long, somewhat immersed, oblique and indistinctly binodose in front, its upper end continued inward as a slender ridge, then



Figs. 1, 2. — *Gastrocopta colombiana*, enlarged aperture and front view of type.

Fig. 3.—Columella and parietal wall seen from below, the peristome above, showing: *c*, columellar lamella; *p*, parietal, and *a*, angular lamellæ.

Fig. 4.—Inside of the palatal wall, the peristome on the right. *s*, supra-palatal fold; *u*, upper palatal; *l*, lower palatal, and *b*, basal fold.

enlarging into a high, stout fold. The basal fold is transverse, weakly bilobed.

Length 2, diameter 0.9 mm.

Colombia: Puerto Columbia, dept. Atlantico, on limestone hills. Morgan Hebard and J. A. G. Rehn, 1920. Type and paratypes no. 46634 A. N. S. P.

Gastrocopta colombiana PILS., Proc. A. N. S. Phila., 1920, p. 329, figs. 1-4.

While this species of the subgenus *Immersidens* is somewhat similar to *G. cochisensis*, *G. dalliana* and other North American snails of the same subgenus, it differs remarkably in the palatal folds, the upper being doubled, probably by division of a primitively single upper palatal, and the lower fold enters so deeply that its full structure can be understood only by breaking out the palatal wall, as in fig. 4.

GASTROCOPTA KLUNZINGERI (Jickeli). Vol. XXIV, p. 120.

The original description of *Ennea insulsa* Preston follows.

"Shell elongately ovate, very minute, cream-colored; whorls 4½, very convex, sculptured with oblique, transverse riblets, the last ascending in front; suture deeply impressed;

aperture subquadrate, armed with a parietal lamella bearing a small, internal, erect denticle towards the base of the outer lip and an internal lamella on the columella; labrum white, outwardly expanded, continuous. [Pl. 1, figs. 14, 15, 16.]

"Alt. 1.75, diam. maj. .75 mm." (*Preston*).

British East Africa: Gazi (type loc., Robin Kemp). Eusso Nyiro River (Preston).

Ennea insulsa PRESTON, Proc. Zool. Soc. Lond., 1913, p. 205, pl. 33, f. 13, 13*a*.

Specimens from Preston, no. 41564 Bryant Walker coll., confirm the provisional reference to *Gastrocopta* made in vol. xxiv, p. 359. The original figures are copied, pl. 1, figs. 14, 15.

The sculpture and form agree with *G. klunzingeri* (Jick.) of Abyssinia. In the specimens from Eusso Nyiro River (fig. 16) the angulo-parietal lamella does not show a spur on the right side where the two lamellæ join. This, however, is shown in the figures of the typical form. Whether the two specimens (one broken) from Eusso Nyiro represent another race, or merely a mutation, cannot be determined from the material at hand; but the typical form apparently does not differ from Jickeli's species.

GASTROCOPTA MOOREANA (E. A. Smith). Pl. 24, figs. 6, 7.

Vol. XXIV, p. 160. Specimens of the original lot from Roebuck Bay, Western Australia, received through the courtesy of the British Museum, are now figured.

The shell resembles *G. larapinta* in contour, but has a special character in the sculpture as seen under the microscope, the striæ being made irregular, and in places interrupted by *malleation* or shallow, uneven pitting, producing sometimes a sort of reticulation, not unlike that of some Nesopupæ (*Indopupa*). The straight angular lamella joins the lip weakly or scarcely. It *does not connect* with the parietal lamella, which is high but not very long. The columellar lamella is high on the columella, and ascends very slightly inward, being nearly horizontal. There are two short palatal folds, the lower being larger and somewhat more immersed. No basal fold. Peristome reflected and thickened moderately within.

Length 2.2, diam. to edge of lip 1.2 mm.; 5½ whorls.

Length 2.1, diam. to edge of lip 1.1 mm.; 5 whorls.

It is easily distinguished by the sculpture, unlike the other Australian species.

Tertiary Species (Vol. XXIV, p. 114).

GASTROCOPTA QUADRIPLICATA (Al. Br.). Vol. XXIV, p. 114.

Fischer and Wenz (Jahrb. Nassau. Ver. Nat., 1914, p. 95) discuss the synonymy of this species and its allies. They state that Al. Braun's name was a *nomen nudum*, and adopt that of *turgida* Reuss. *G. didymodus* and *fissidens* also are figured in the same excellent paper.

GASTROCOPTA ACUMINATA (Klein). *Pupa acuminata* Klein, Jahresh. f. vaterl. Nat. in Württ., ii, 1846, p. 95, pl. 1, f. 19.—*Leucochila acuminata* (Kl.), Wenz, Nbl. d. Malak. Ges., 1916, p. 62. According to Wenz this includes *quadridentata* Klein, Vol. XXIV, p. 115, no. 47. A var. *procera* is described, p. 64, pl. 1, f. 5. As this name is preoccupied for a recent species, Wenz's form may be called *G. acuminata wenziana*.

GASTROCOPTA (?) CAPITANI (de Morgan). *Pupa* (*Pupilla*) *capitani* J. de Morgan, Bull. Soc. Geol. France (4), xix, November, 1920, p. 316, fig. 11. Faluns de Touraine: Pont-Levoy, sablière de Charmenton (Miocene).

M. G.-F. Dollfus (Etude sur la Molasse de l'Armagnac, in Bull. Soc. Geol. France (4), xv, 1915, has reviewed the Sansan Pupillidæ, reducing most of Bourguignat's species to synonyms. He does not seem to have a clear conception of the distinction between *Gastrocopta* and *Vertigo*, placing all the species under "*Vertigo* (*Leucochilus*)."

GASTROCOPTA NOULETIANA (Dupuy). Vol. 24, p. 116. Under "*Vertigo* (*Leucochilus*) *nouleti*" Dollfus places as synonyms: *Vertigo ludovici, barreri, necra* and *cyclophora?* of Bourguignat.

The synonymy and distribution have also been discussed by Wenz, Nachrbl. D. M. Ges., 1916, p. 65.

GASTROCOPTA LARTETI (Dupuy). Vol. 24, p. 115. Dollfus

(p. 361) gives the following synonyms: *Vertigo chydaea, V. eucrina, V. tapeina, V. campanea, V. codiolena, V. edwardsi* [*milne-edwardsi* Bgt.], *V. rhynchostoma, V. micronixia,* all of Bourguignat. The last two he separates on a subsequent page of the same paper.

Tertiary Species of *Abida*. Vol. XXIV, p. 269.

ABIDA SUBVARIABILIS mut. ULMENSIS Wenz. *Torquilla s. u.,* Wenz, Jahresber. u. Mittheil. Oberrhein. Geol. Ver., (n. F.), vii, 1918, p. 20.

ABIDA SCHLOSSERI (Wenz). *Torquilla schlosseri* Wenz, Senckenbergiana, i, 1919, p. 66, new name for *Pupa* (*Vertigo*) *oviformis* Schlosser, Jahrb. k. k. geol. Reichsanst., lvii, 1907, p. 757, pl. 17, f. 5, not *P. oviformis* Michaud, 1838.

GYLIAUCHEN (Vol. XXIV, p. 210).

GYLIAUCHEN AUSTRALIS (Odhner). Pl. 24, figs. 11, 12, 13.

Shell pyramidal, with convex whorls and deep sutures; last whorl dilated, with an angular periphery and a protracted aperture. Peristome continuous, expanded all around. Aperture rounded heart-shaped, with 5 teeth, two on the parietal wall, two on the outer wall, and one on the columella. Sculpture consisting only of oblique fine lines of growth. Umbilicus deep, widening below and surrounded by a basal keel. Color light brownish. Height 2, greatest diam. 2.7, height of aperture 1.1 mm. (*Odhner*).

Australia: caves at Chillagoe, Queensland; subfossil (Swedish Sci. Exped. to Australia, 1910-1913).

Hypselostoma australis ODHNER, Res. Dr. E. Mjöberg's Swedish Sci. Exped. to Australia, 1910-1913, xvii, Mollusca, in Kungl. Svenska Vetenskapsakad. Handlingar, Bd. 52, no. 16, 1917, p. 98, pl. 3, f. 107-109.

This species appears to be most nearly related to *G. dohertyi* Fulton (Vol. 24, p. 219), of Tenimber Island, which is also its nearest neighbor geographically. Dr. Odhner considers it "a further proof of the former connection of Australia and New Guinea, the only possible way of its invasion."

Vol. XXV. VERTIGININÆ.

VERTIGO. Vol. XXV, p. 69.

In a list of German and Austrian shells (Nachrbl. D. M. Ges., 43, March 1911, p. 24) C. R. Boettger has "*Vertigo* (*Alaca*) *alpestris* Ald.," followed by seven other species under the same generic and subgeneric names. As *Alaca* occurs above it on the same page, it is possible that *Alaca* is intended as a new section, and not a typographical error for *Alaea*. In that case it may have *V. alpestris* for type; but I am inclined to think it unintentional, as it is not designated as new.

CRATICULA Lowe, P. Z. S., 1854, p. 211 (March 27, 1855), type designated as *P. substriata* Jeffr., becomes subordinate to *Vertigo*, and can be used as a sectional name for the group of *V. substriata* (see Manual, Vol. 25, p. 172) if that is considered sufficiently distinct to need special designation.

VERTIGO PUPÆFORMIS Pollonera. Page 379.

The reference to figure should be: Vol. XXVI, pl. 11, fig. 13.

VERTIGO EUMICRA (Bgt.). Pl. 20, fig. 11.

Shell rimate, under the lens slightly striatulate obliquely; at the apex very obtusely rounded. Whorls 6, convex, slowly and regularly increasing, separated by a deep suture, the last whorl one-fourth the length, straight or slightly ascending at the aperture. Aperture toothless, a little oblique, rounded; peristome acute, simple, not reflected or thickened, the margins strongly approaching. Length 3, diam. 2 mm. (*Bgt.*).

Switzerland: Under leaves in the ruins of the castle of Habsburg, not far from Meggen, half way on the road between Lucerne and Kussnacht (Bgt.); St. Moritz in the Engadine, on granite, at about 1800 meters (Clessin).

Vertigo eumicra BOURGUIGNAT, Revue et Mag. de Zool., 1862, pl. 18, f. 11, 12; 1863, p. 5. — H. SCHLESCH, Hall Mus. Publications, no. 116, 1919, p. 29, fig. *b*.—*Pupa eumicra* CLESSIN, Malak. Bl., xxv, 1878, p. 85, pl. 3, f. 11.

Clessin believes that the original description was from immature examples. When entirely adult the margins of the lip

are joined by a parietal callus. He states that it differs from *Pupa inornata* (*P. edentula* auct.) by the connected peristome; moreover the summit is more Vertigo-like, the size smaller, and the striation more distinct. It has usually been placed in *Pupilla*, but may more likely be a toothless Vertigo close to or specifically identical with *V. genesii* Gredler (Vol. XXV, p. 204), as claimed by Schlesch. Bourguignat's figure is copied in our pl. 20, fig. 11, Clessin's in pl. 20, fig. 21.

VERTIGO HINKLEYI n. sp. Pl. 6, figs. 12-16.

The shell is minute, oblong-cylindric, of cinnamon-buff color, glossy, nearly smooth, very thin. The whorls are rather convex, the last three forming the more or less cylindric portion; the last whorl tapers to the narrow base; there is a depression behind the auricle of the lip, and behind that a larger, deeper dorso-lateral impressed area extending nearly to the base. The aperture is shortly piriform, with strongly defined sinulus, limited below by a deeply bent in and thickened angle of the outer lip. The peristome is slightly expanded around the sinulus, elsewhere strongly so. The parietal lamella is rather remote from the edge of the thin parietal callus, low in front, high within, and enters deeply. The columellar lamella is deeply placed, not very long, ascending a little inwardly. Below it there is a subcolumellar tooth (probably a shifted basal fold). The upper palatal fold is a high lamina, abrupt in front, where it arises some distance within the lip. Close to its inner end there is a short fold, apparently the lower palatal; only its anterior end can be seen in the aperture.

Length 1.55, diam. 0.75 mm.; 5½ whorls. Type.

Length 1.75, diam. 0.77 mm.; 6 whorls. Type.

Arizona: Cave canyon, Huachuca Mountains, at Station 295, near the reservoir (Hinkley and Ferriss, 1919). Type no. 46243, A. N. S. P. Also two specimens at Station 296.

This remarkable little *Vertigo* is so unlike known species that comparisons need not be made. The peculiar shape of the aperture is characteristic, and the teeth differ strongly from all other species.

In a few examples the parietal lamella emerges nearly to the edge of the parietal film. The aperture also varies individually in width.

At Station 295 it was associated with *Vertigo coloradensis inserta* and single specimens of *Gastrocopta ashmuni* and *G. pilsbryana*.

Fossil species of Vertigo. Page 214.

VERTIGO PONTILEVIENSIS de Morgan. Bull. Soc. Geol. France (4), xix, Nov. 1920, p. 317, fig. 12. Faluns de Touraine: Pont-Levoy, sablière du vallon de Charenton (Miocene).

VERTIGO TURONICA de Morgan. *Op. cit.*, p. 318, fig. 13. Same locality.

VERTIGO DOUVILLEI de Morgan. *Op. cit.*, p. 319, fig. 14. Same locality.

VERTIGO ROBERTI de Morgan. *Op. cit.*, p. 320, fig. 15. Same locality.

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Page 24. PUPISOMA EVEZARDI (Blanf.) was taken by Lieut.-Col. A. J. Peile at Panchganni, about 12 miles inland from Mahablishwar, on bark of trees near road, and at Lanauli, a couple of miles on the Poona side of Khandala, at the top of Bor Ghat, on trees and bark (128417-8 A. N. S. P.).

Page 24. The reference for *Pupisoma lignicola* var. *unidentata* G.-A. is Land and Freshwater Moll. India, ii, 1910, p. 300.

Page 36. Add to references under PUPISOMA DIOSCORICOLA: *Microphysa dioscoricola* C. B. Ad., W. G. BINNEY, Bull. M. C. Z., xix, 1890, p. 196, pl. 3, f. 6 (shell, jaw and teeth). The localities given are: St. Augustine, Blue Spring, St. Johns River, Lake Worth to Hawk's Park, Hilo River emptying into Mosquito Inlet, Florida; Hidalgo, Texas.

Page 45. 12th line from bottom: for *Pupa kingsi* read *Pupa kingi*.

Page 51. 20th line: for DRONET read DROUET.

Page 106. 13th line: for *basal lamella* read *basal fold*.

STERKIA BAKERI n. sp. Pl. 24, figs. 1, 2, 3.

The shell is thin, straightly rimate, imperforate, cylindric, ochraceous-tawny; surface very weakly but regularly striate, with traces of weak granulation in places. The whorls are strongly convex. The aperture is obstructed by five teeth. The angular lamella is strong and high, curved, much shorter than the parietal lamella, which is high and long, entering very deeply. The columellar lamella is situated high, and slants rapidly upwards within. Upper-palatal fold is strong, rather long, marked externally by a slight depression. The lower-palatal is much more deeply placed, about equal to the upper. The peristome is tawny, reflected, the outer margin bent in a little in the middle. Length 1.9, diam. 0.9 mm.; fully 5 whorls.

Mexico: southern part of the State of Vera Cruz, Canton of Acayucan, at the Hacienda de Cuatotolapan, between the Rio San Juan and its tributary the Arroyo Hueyapan (H. Burrington Baker).

In its proportions, the diameter about half of the length, this species resembles *S. rhoadsi*. It differs by the more obtuse summit, the more distinctly striate surface and the stronger and longer teeth, of which the lower palatal is more deeply immersed. The inner end of the parietal lamella is not visible in an obliquely basal view in the aperture, but it also passes out of sight inward in *S. rhoadsi*, though weaker within than the present species.

S. antillensis is a shorter, broader shell, with less immersed lower-palatal fold. The parietal lamella is long, as in *rhoadsi* and *bakeri*. In *S. eyriesi* the parietal is distinctly shorter.

The tropical American Sterkiæ evidently form a complex of intimately related races. It is not possible to judge their specific distinctions by the very small number of specimens now known, from a few widely separated localities.

TRUNCATELLINA CYLINDRICA (Fér.). Page 65. Reference to figures should be: Pl. 8, figs. 3, 4, 8.

Locard has distinguished the varieties *major, minor, curta* and *ventricosa*, "defined by their names," and probably from

France. He states that the Portuguese specimens are larger than those of France (*Isthmia muscorum* Drap., Locard, Archives Mus. d'Hist. Nat. Lyon, vii, 1899, p. 153). It has been reported from Portugal by Morelet and Castro.

According to Clessin the following is a synonym: *Pupa pusillima* Forster, in Fürnrohr's Naturhist. u. Topographie Regensburg, 1838-40, no. 59 (not seen by H. P.).

Add the following to the list of fossil species, p. 60:

TRUNCATELLINA PODOLICA (Lomnicki). *Pupa podolica* Lom., Verh. K. K. Geol. Reichsanst., 1886, p. 423. Miocene, Folwarki, Galizia.

Page 78. The following species should be inserted:

12*a*. TRUNCATELLINA SCHARFFI (Boettger).

It is easily to be distinguished from *P. minutissima* Hartm. (*T. cylindrica* Fér.) and its varieties *dentiens* Moq.-Tand. and *odontostoma* West. by having a strong basal tooth, a long, rather forwardly advanced palatal tooth, weak columellar tooth, and the nearly smooth surface of the shell. Also from *P. strobeli* Gredl. (which appears to be distributed throughout Italy, as I have positively identified examples from Naples and Messina), the French form appears so much more amply distinct by the weaker sculpture of the shell, the greater size, and by having an additional whorl, that I view it as new, and would preliminarily name it *P.* (*Isthmia*) *scharffi*, after its discoverer (*Bttg.*).

France: débris of the Garonne near Bordeaux (Robert Scharff).

P[*upa*] (*Isthmia*) *scharffi* BOETTGER, Nachrbl. D. M. Ges., xi, May, 1879, p. 51.—*P. strobeli* var. *scharffi* Bttg., WESTERLUND, Fauna, p. 126.

This form was referred to on p. 72, but by oversight the description was omitted. The reference to Boettger was incorrectly given.

PUPOIDENS LARDEUS (Pfr.). Page 126.

Lieut.-Col. A. J. Peile, who collected *lardeus* in Bombay

Island, writes that he is "disposed to believe it distinct from *cœnopictus,* as the Bombay specimens are all alike. In picking over some shell sand from Karachi beach, however, I found an apparently mixed race, varying much in size." These may have been washed together from several colonies.

Page 158, line 8: In place of "Three-tooth mutations" read "Four tooth-mutations."

Pupilla blandi mut. *alba* (Ckll.). Page 160.

Shell white. Custer Co., Colorado (T. D. A. Cockerell, Science Gossip, xxiv, Nov. 1888, p. 257).

Pupilla cupa turcmenia Bttg. Page 188.

The first two paragraphs on p. 188 should follow the account of *P. c. turcmenia,* having been transposed above it accidentally.

Of Uncertain Position.

Pupa lamarckii Audouin. Pl. 24, figs. 8, 9, 10.

Known only by Savigny's figures, here reproduced photographically, which represent a short shell with expanded lip and a carina on the last whorl. The latter looks like the remains of a whorl which has been broken away, the animal afterward forming a lip at the limit of the breach. I have seen such specimens; and I suspect that it is a pathologic *Pupilla.* The length as indicated on the plate is 2.8 mm. Presumably from Egypt.

Pupa lamarckii Audouin, in Descript. de l'Egypte, xxii, 1826, p. 161; referring to Savigny's figures in the same work, Hist. Nat., Zoologie, ii, Coquilles, pl. 2, f. 1.—*Bulimus lamarckii* Aud., Issel, Malac. Mar Russo, 1869, p. 321.

EXPLANATION OF PLATES

Except where stated otherwise, the specimens figured are in the Museum of the Academy of Natural Sciences and were drawn by Miss Helen Winchester. With few exceptions, the borrowed figures have been reproduced photographically.

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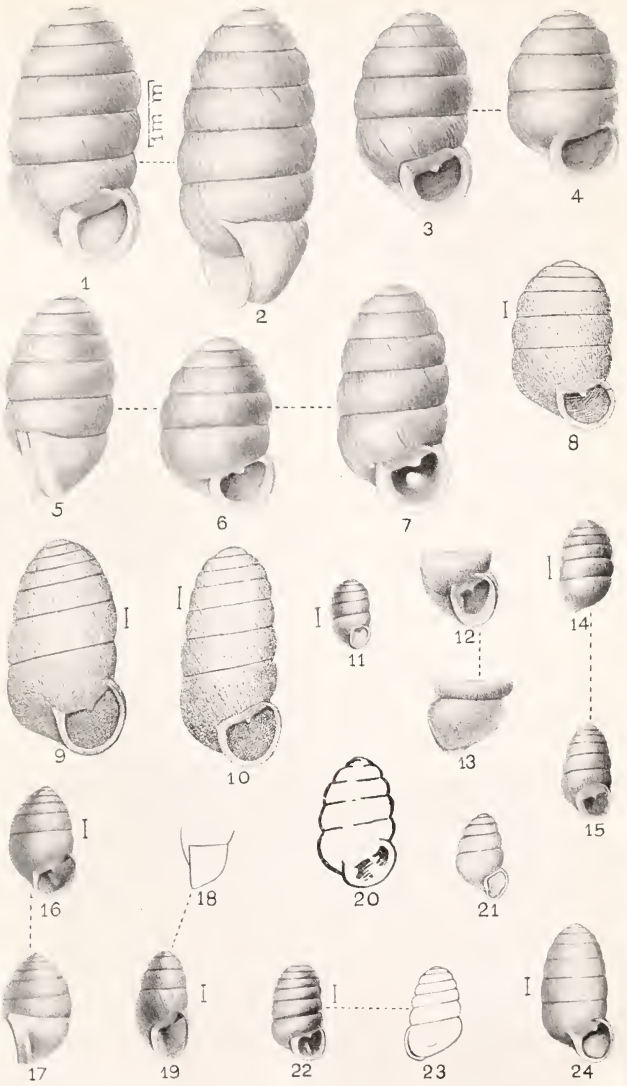
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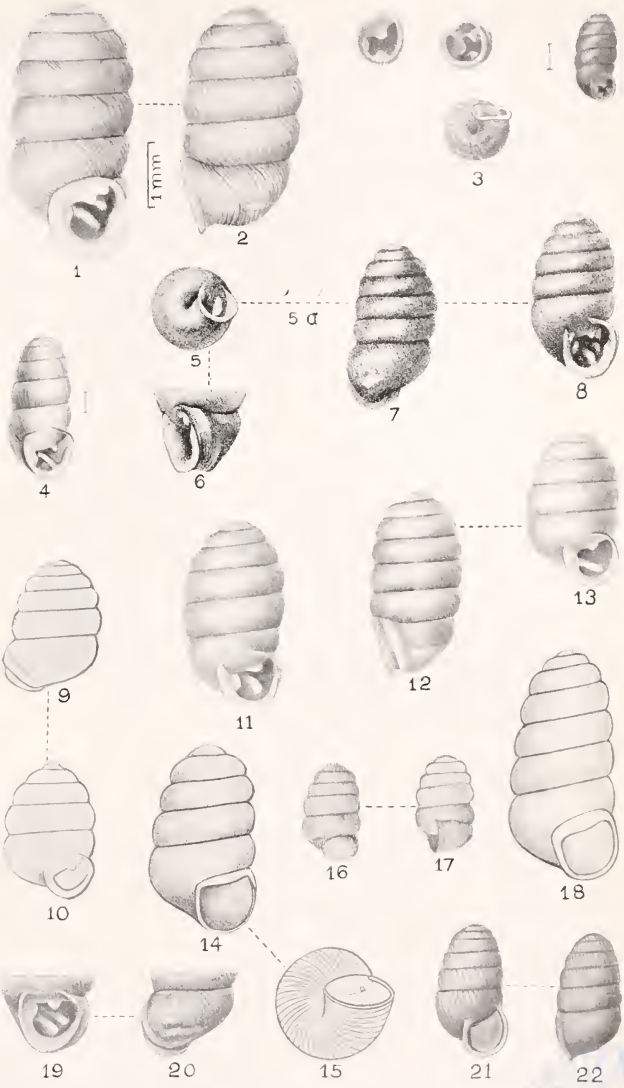
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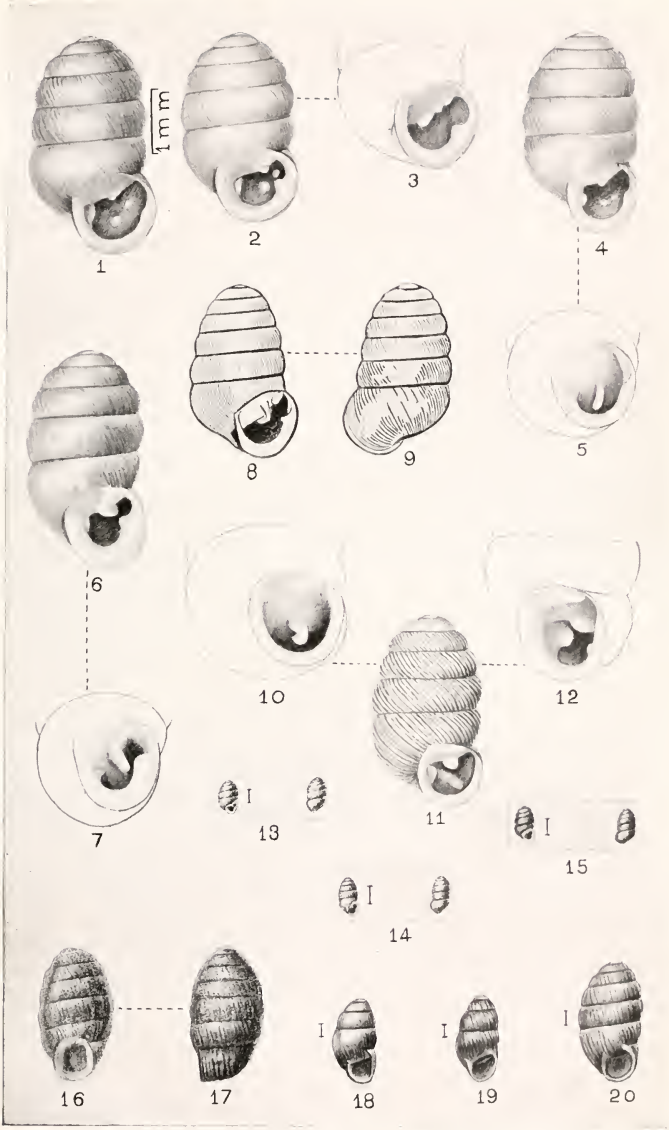
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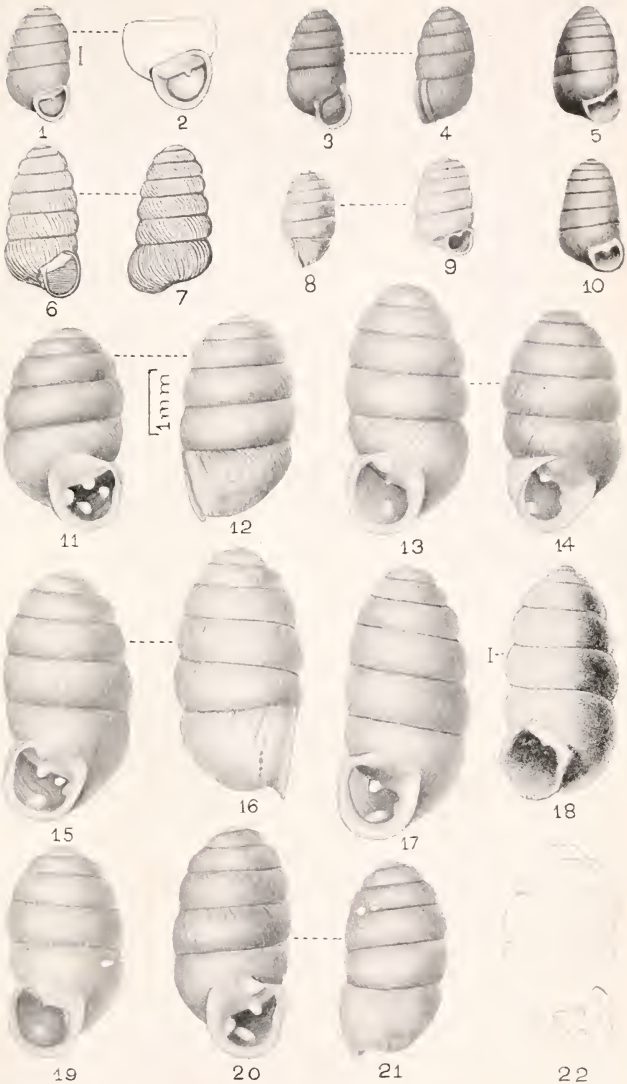
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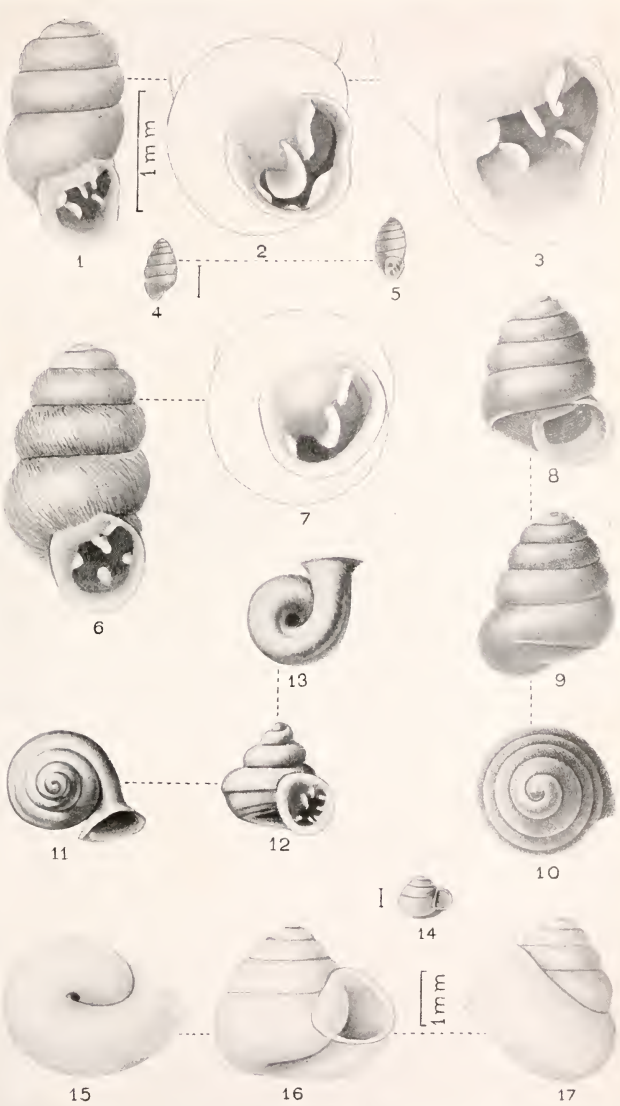
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